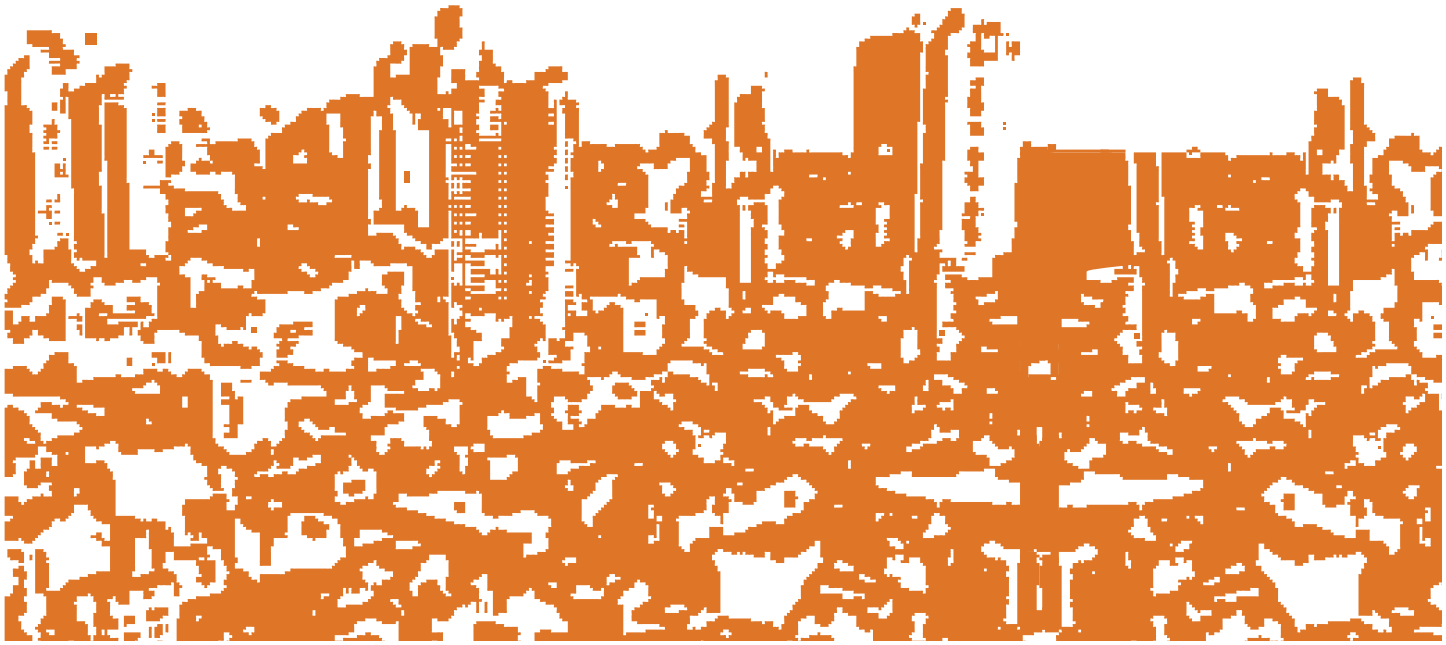
Asian Cities Climate Resilience

WORKING PAPER SERIES 11: 2014

Strengthening resilience against disasters and climate change

Sustainable energy in Quy Nhon City

BY MAARTEN AKKERMAN, HOANG THANH BINH AND DANG THU PHUONG



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Acronyms

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ACCCRN	Asian Cities Climate Change Resilience Network
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CBDRM	National Target Programme of Community-Based Disaster Risk Management
CCFSC	Central Committee for Flood and Storm Control
CCCO	Climate Change Coordination Office
CCVI	Climate Change Vulnerability Index
DOIT	Department of Industry and Trade
DPP	Disaster-preparedness planning
DRR	Disaster risk reduction
DRM	Disaster risk management
EVN	Vietnam Electricity
GEA	Global energy assessment
GDP	Gross domestic product
GHG	Greenhouse gas
HVCA	Hazard, vulnerability and capacity assessment
IPCC	Intergovernmental Panel on Climate Change
MOIT	Ministry of Industry and Trade
MoNRE	*Ministry of Natural Resources and Environment*
NTP-RCC	National Target Programme to Respond to Climate Change
NGO	Non-governmental organisation
ODA	Official development assistance
PPP	Purchasing power parity
PDP	Power development plan
SHS	Solar home system

SSRE	Small-scale renewable energy
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
VGGS	Vietnam Green Growth Strategy

Acknowledgements

This research would not have been possible without the help of many others and we would like to take this opportunity to thank those who have contributed. First, we would like to thank Ha Thi Hong Hai and Nguy Thi Hoan for their help with the data collection. Thanks are also due to Hoan for facilitating the workshops in Quy Nhon. We would like to thank Nguy Thi Khanh, executive director of GreenID, for her valuable comments on the energy policy. We owe special thanks to Julia Tomei, whose comments and inputs greatly enhanced the quality of the report.

Second, the success of this research project is in large part due to GreenID's partners, particularly the Red Cross of Binh Dinh Province. We would also like to express our gratitude to Tran Dinh Ky and his colleagues for making the careful arrangements for the fieldtrips and workshop on climate change and sustainable energy, as well for as their enthusiastic participation in the data collection. We would like to thank all the participants including those from the Department of Industry and Trade, the Women's Union, the Committee for Flood and Storm Control, Quy Nhon City's Climate Change Coordination Office, Quy Nhon City's People's Committee, and Quy Nhon City's Red Cross. Finally, we would like to thank the participants in Nhon Ly and Nhon Hai for taking the time to participate in our survey and workshop in spite of the terrible weather caused by Typhoon Nari.

Abstract

This paper investigates the relationship between disasters and energy supply in the coastal city of Quy Nhon, Vietnam. Although increasing attention is being paid to this issue, there are few studies that investigate the impacts of energy perturbations following extreme weather events. Drawing on multiple methods, including survey questionnaires, focus groups and key actor interviews, this research focuses on the coastal communes of Nhon Ly and Nhon Hai, Quy Nhon. The principal livelihoods in these communes are fishing and seafood processing, livelihoods which are likely to be particularly affected by climatic changes. The research finds that while all participants were connected to the electricity grid, they also experienced disruptions to their supply which were exacerbated during times of water stress and natural disasters, including typhoons. The impacts of perturbations in the energy supply include higher costs for alternative energy sources, the need to hire additional labour and worsened working conditions. This research also finds that, in spite of awareness of climate change and its impacts, adaptation measures are not being considered either by households or the commune. Instead, commune authorities and residents rely on coping mechanisms after the disasters have struck. Vulnerable groups, including women, fishermen and seafood processors, who have less access to financial capital, are particularly affected by disasters. Small-scale renewable energy (SSRE) technologies could provide major benefits for these communes. SSREs include micro-wind and biogas energy-generation technologies, as well as improved cooking stoves and solar-powered lanterns. However, the adoption of these technologies is limited by financial constraints and unfavourable energy markets. The paper concludes with recommendations for how to increase energy resilience in the face of increased disaster risks, which include changes to the energy market, adequate financing mechanisms and participatory local energy planning to help the poorest households.

1 Introduction

Vietnam has been classified as a country at extreme risk of climate change (Maplecroft 2014; Harmeling 2011). The risks for Vietnam are high because of its geography: it has a long coastline, many rivers and is located in a region where typhoons frequently occur. By 2050, an estimated 10 million people in Vietnam will be vulnerable to sea-level rises, an increase from 6 million in 2008 (Wheeler 2011). The Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Report concludes that anthropogenic climate change is likely to exacerbate weather-related disaster risks such as droughts, and is very likely to increase the frequency and severity of tropical cyclones and flooding (IPCC 2014). One assessment of global vulnerability to climate change places Vietnam eleventh in both 2008 and 2015 (Wheeler 2011), another places it 23rd (Harmeling 2011). Rising incomes, urbanisation and improved regulation will have a positive impact for some, but these benefits will be offset by the increased likelihood of extreme weather events (ibid). Although the percentage of the population living below the poverty line is expected to fall, consideration of the ways in which poor people will be affected by climate change remains critical.

Within Vietnam, the central coastal area has been identified as the most at-risk and exposed region (World Bank 2010a). Coastal areas are especially prone to storms, flooding and droughts, which are caused by changes in precipitation patterns. More extreme weather events are also likely to cause disruptions to energy systems. For example, storms and floods may damage energy infrastructure, while droughts may lead to problems with cooling water for power plants and to low levels in hydropower reservoirs. Disruptions in energy supply have consequences for people's day-to-day lives and may affect their incomes, thereby increasing their vulnerability. Here, we use a definition of vulnerability which defines it as:

> *The characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society* (Blaikie *et al.* 1994: 11).

There is, however, only limited research on the relationship between disasters, energy supply and the impacts of disruptions in energy supply on people. Our research aims to address this evidence gap.

1.1 Aims and objectives

In this report, we investigate the impacts of disaster-induced energy perturbations on the livelihoods of small-scale seafood producers, fishermen and poor households in Quy Nhon City. Quy Nhon is the capital of Binh Dinh Province, located on the south central coast of Vietnam (Appendix 1). Due to its coastal location, Quy Nhon is at risk from climate change and is likely to experience more weather-related disasters. It is therefore important to investigate whether and how energy systems in Quy Nhon can be made more disaster resilient.

A previous study had identified these groups as being particularly vulnerable to climate change and they were therefore selected for this study (Challenge to Change *et al*. 2009). Our research had the following objectives:

- To assess energy demand, energy status and access to resources amongst vulnerable groups, specifically fishermen, small-scale seafood producers and poor households.
- To identify suitable alternative energy solutions for vulnerable groups, as well as the opportunities for and barriers to the uptake of these solutions.
- To evaluate disaster-preparedness planning, in particular how energy provision is taken into account in disaster-preparedness planning, and how the energy needs of vulnerable people can be better incorporated.

1.2 Structure of the report

The report begins with a review of the literature on climate change, disaster risk and variability in disaster occurrence. In this review, we also discuss the impacts of disasters on energy supply. In the next section, we then set out the aims and objectives of this research. There follows a review of Vietnam's energy and climate policies, and a summary of possible small-scale renewable energy options. In the third section we describe the methodology adopted, while in the fourth section we describe the results of the research. In the final section, we draw some conclusions and set out some recommendations for increasing energy resilience in the face of future climatic changes.

2 Background

In this section of the report, we discuss the background to the issues of disaster-resilient energy supply in Vietnam. We first highlight climate change, the disaster risks associated with it and the concept of vulnerability. This is followed by an explanation of disaster-resilient energy supply and climate change in Vietnam. We end by discussing Vietnam's energy market, local energy initiatives in Vietnam, the central region and Quy Nhon City and small-scale renewable energy technologies.

2.1 Climate change, disaster risks and vulnerability

The IPCC's Fifth Assessment Report, published in 2013, concluded that warming in the climate system is unequivocal (IPCC 2013). Rising temperatures and extreme weather events, including droughts, flooding and increased frequency and intensity of tropical cyclones, are likely to increase the occurrence of climate-related disasters (IPCC 2007). The United Nations' International Strategy for Disaster Reduction reports that, between 1988 and 2007, about two thirds of all disaster events were of a climatological nature (UNISDR 2008). These climatological disaster events accounted 'for approximately 45 per cent of the deaths and 80 per cent of the economic losses caused by natural hazards' (UNISDR 2008: 5). It is these climatological disasters that will happen more often and that will be more severe as global temperatures rise. The UNISDR (2008) recognises two ways in which climate change can affect disaster risk: First, the likely increase in weather- and climate-related hazards; and Second, the increased vulnerability of communities. These risks are exacerbated by additional stresses to the environment, such as degradation and rapid unplanned urban growth.

That climate change will intensify the impacts of disasters, which will have the greatest impact on already vulnerable, poor population, has been a focus of much research and a priority of multilateral donors such as the World Bank, the Asian Development Bank (ADB), and international development agencies. Poverty has been identified as a key determinant of vulnerability to climate change, one which limits the capacity of communities to adapt. Oxfam (2010: 3)argues that:

> *Access to and control over land, money, credit, information, health care, personal mobility and education combine to determine the ability to survive and recover from disasters and to make long-term changes and investments to adapt.*

Gender inequalities mean that women are particularly vulnerable to the impacts of climate change, which together with poverty undermines their ability to adapt (Oxfam 2010). An additional problem for poor and vulnerable households is problems with the energy supply during, before and after disasters. Although the definition of energy poverty is contested, we follow Reddy's (2000: 44) definition of energy poverty as:

> *... the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development.*

Disasters may lead to a temporary state of energy poverty or can worsen the situations of people that are in a permanent state of energy poverty. For households and enterprises which require an energy supply for producing goods and services, this means that production costs will increase, thus leading to reduced incomes and revenues; for example, due to the loss of refrigerated goods.

Two key approaches to dealing with disasters and their effects can be identified: adaptation and coping measures. Adaptation measures aim to reduce the effects of disasters by structurally changing methods (such as production processes) and systems so as to avoid adverse impacts or to benefit from the changed circumstances. Adaptation measures can be planned, for example by a government, or they can be autonomous, initiated by local people themselves. Conversely, coping mechanisms aim to deal directly with the consequences of a disaster, and are thus more reactive and temporary by nature. Adaptive measures are generally longer lasting and more aimed at systematic change than coping mechanisms (Oxfam 2010; Care 2009).

2.2 Disaster-resilient energy supply

Although growing attention is being paid to the issue of disaster-resilient energy supply, to date it has been neglected in debates on climate change and energy. This neglect is surprising given the importance of energy to development and economic growth (Urban and Mitchell 2011).The 2012 Global Energy Assessment, for instance, makes no mention of disaster preparedness (GEA 2012), yet the IPCC (2007: 367) argues that:

> *Climate change could affect energy production and supply: (a) if extreme weather events become more intense (as this can damage vital infrastructure), (b) where regions dependent on water supplies for hydropower and/or thermal power plant cooling face reductions in water supplies, (c) where changed conditions affect facility siting decisions, and (d) where conditions change (positively or negatively) for biomass, wind power or solar energy production.*

The Fourth IPCC Assessment argues that climate change may affect energy systems through both weather-related disasters and changing consumption patterns (IPCC 2007). For example, higher temperatures are likely to increase demand for cooling and reduce demand for heating. As the quote by the IPCC highlights, climate change is expected to affect the power sector in its entirety from fuel mining and production to fuel transportation, power plants, electricity generation and transmission from high-voltage grids to low-voltage distribution to consumers (ADB 2012).

A report by the World Bank and Australian AID (2012) suggests three types of preparation measures to prevent energy and communication systems from being disrupted. The first measure concerns the location of vital infrastructure, which the report argues should be located on higher ground to ensure safety from flooding and landslides. The second measure is structural, and includes those that aim to strengthen physical structures. An example would be to build a protective wall around an energy facility. The third set of measures is operational, and includes ensuring sufficient back-up capacity and adequate procedures are in place to deal with power failures.

There have been few projects that have focused on disaster resilience and energy, although a World Bank-funded project in the Philippines provides one example: this US$ 13 million project centred on the Bicol region, where a typhoon had damaged the energy supply system. Several measures were implemented to strengthen energy transmission, including the installation of storm-resistant power transmission lines. The project benefitted an estimated five million people, and reduced the blackout time after storms (World Bank 2009). This project provides an example of the implementation of structural and operational measures to increase energy resilience (Worldbank and Australian AID 2012). A study by Intellecap (2010) highlights the possibilities for private enterprises to invest in off-grid renewable energy because such systems may be more resilient to disasters. The report argues that decentralised energy systems are also less likely to suffer from mismanagement: First, because energy choices are made locally; and Second, because the choices that must be made are different. For instance, in the case of a power shortage, local people may decide to use only essential appliances rather than cut the energy supply to houses.

While this topic has received recent attention in the US following Hurricane Sandy (Grabar 2013), there remains a evidence gap on the impacts of disasters and climate risks to energy supplies and the way in which this impacts on local people's lives. In particular, there is little research on alternative energy choices – either energy supply or infrastructure – especially for vulnerable and marginalised groups who will be most affected by climate change. It is for this reason that Urban and Mitchell (2011) call for more studies on the impacts of climate change on electricity systems in the developing world. Our research aims to address this research gap by focusing on disaster-resilient energy supply in Quy Nhon, Vietnam.

2.3 Climate change in Vietnam

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) cautions that the impact of climate change on typhoons in the Asia Pacific region is highly uncertain. This uncertainty is mainly a consequence of the lack of data (UNESCAP WMO Typhoon Committee 2012). However, other assessments report that the frequency of typhoons in the region is expected to increase (Chaudhry and Ruysschaert 2007; ACCCRN 2013). Within Vietnam, coastal wards and communes will be amongst the areas most vulnerable to climate change. Quy Nhon – the focus of this research – is one city that is expected to be adversely affected by climate change.

Quy Nhon is regularly subject to water-related disasters including droughts and flooding (Challenge to Change *et al.* 2009). In addition to these disasters, the city's location means that it is vulnerable to other environmental hazards such as coastal and lagoon-side erosion, saline intrusion and sand displacement.[1] The latter particularly affects poorer communities living in coastal areas and alongside rivers. In almost every year between 2004 and 2009, the city was affected by disasters, particularly flooding events, which were exacerbated by land erosion. In 2007, for instance, the city experienced a severe flooding event which lasted twenty days; several people died and livelihoods were disrupted. Water-level rises and flooding pressure also caused damage to dykes, irrigation systems and infrastructure, including roads and buildings. The city is also vulnerable to storm surges and coastal flooding, effectively leaving the city vulnerable to flooding on two sides. Box 1 provides a chronological description of the impacts from Typhoon Mirinae, which struck Quy Nhon in 2009.

Box 1. Timeline of Typhoon Mirinae, 2009

On the 31st October 2009, the Central Storm Forecasting Agency announced that the rapidly approaching Typhoon Mirinae was powerful and expected to produce up to 400mm of rain in Central Vietnam. On the same day, Deputy Prime Minister Hoang Trung Hai issued disaster preparation instructions. On the 2nd November, all public schools in Binh Dinh were closed and people were advised to prepare for a severe storm. Over the next two days, the hydro-meteorological station at Van Canh, Binh Dinh recorded 801mm of rainfall. In Binh Dinh, 22 people were reported dead. According to Binh Dinh's Department of Agriculture and Rural Development, Mirinae was the worst storm to hit Central Vietnam in 34 years. According to Quy Nhon's economic office, Typhoon Mirinae killed seven people and caused roughly VN$ 374.5 billion (US$ 21 million) in damages. Based only on this damage assessment, Mirinae may have been the most costly storm to hit the city in living memory (Di Gregorio 2011).

Climate change is expected to lead to sea-level rises of at least one metre (World Bank 2010b), as well as to an increase in the frequency and intensity of storms. As a result, the risk of flooding in Quy Nhon is expected to increase. According to the scenarios from the Quy Nhon City action plan, the average temperature of Quy Nhon City in the 21st century seems to have increased over time, with the highest increases in March to May (Huy 2012). According to the high (A1F1), average (B2) and low (B1) emission scenarios, the average temperature increase in the city is projected to be 1.3°c, 1.2°c and 1.1°c respectively. Towards the end of the 21st century, average temperature increases of 2.9°c, 2.3°c and 1.5°c are projected. Climate change will also cause changes in precipitation patterns, for example less rainfall is likely to fall in the dry season, whilst in the rainy season rainfall is expected to increase. By the end of the century, rainfall is expected to increase by 8.9 per cent (A1F1), 7.0 per cent (B2) and 4.6 per cent (B1) (Huy 2012).

1 *Sand displacement happens when sand is blown away by the wind, which can lead to serious damage to agriculture and fisheries nearby and can have adverse impacts on human health.*

2.4 Climate policies

Vietnam has made great efforts in addressing climate change and disaster issues both at the international and national levels. Vietnam ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and 1994, the Kyoto Protocol in 1998 and 2002 and the Hyogo Framework for Action in 2005. At the regional level, Vietnam ratified the Association of Southeast Asian Nations (ASEAN) Agreement on Disaster Management and Emergency Response (AADMER) in 2009. Since 2008, the Vietnamese government has issued a number of key policies and strategies to deal with climate change. These include:

- The Law on Natural Disasters Prevention and Response, which came into effect in June 2013.
- The 2011 National Strategy on Climate Change. The strategy has the following objectives: to optimise the capacity of the country to deal with climate change; to adopt climate change adaptation and greenhouse gas (GHG) emission reduction measures; to safeguard people's lives and property; to promote sustainable development goals; to strengthen human and natural system resilience to climate change; to develop a low-carbon economy to protect and enhance the quality of life; to ensure national security and sustainable development in the light of climate change; and to share efforts with the international community to protect the global climate system.
- The 2012 National Green Growth Strategy for the period 2011–2020 (with a vision to 2050). The strategy aims to promote green growth as a means of achieving a low-carbon economy. It also aims to enrich natural capital, which is envisaged to become the principle direction in sustainable economic development. It also promotes the reduction of GHG emissions and an increased capability to absorb GHG. The focal point for actions lies at the ministerial level.
- The 2008 National Target Programme to Respond to Climate Change (NTP-RCC). To date there are 16 NTPs, which are each reduced into three groups of projects which focus on: assessing the level of climate change and developing climate change and sea-level rise scenarios; developing and implementing action plans to respond to climate change; and strengthening capacity, communications and monitoring and evaluation of programme implementation. Although Quy Nhon established a Climate Change Coordination Office (CCCO), the NTP does not require cities to set up such offices.
- The 2009 National Target Programme of Community-Based Disaster Risk Management (CBDRM). This programme has two main components: to strengthen capacity for managing and implementing CBDRM for local officers at all levels; and to improve communication and education, enhancing the capacity of communities in disaster risk management.

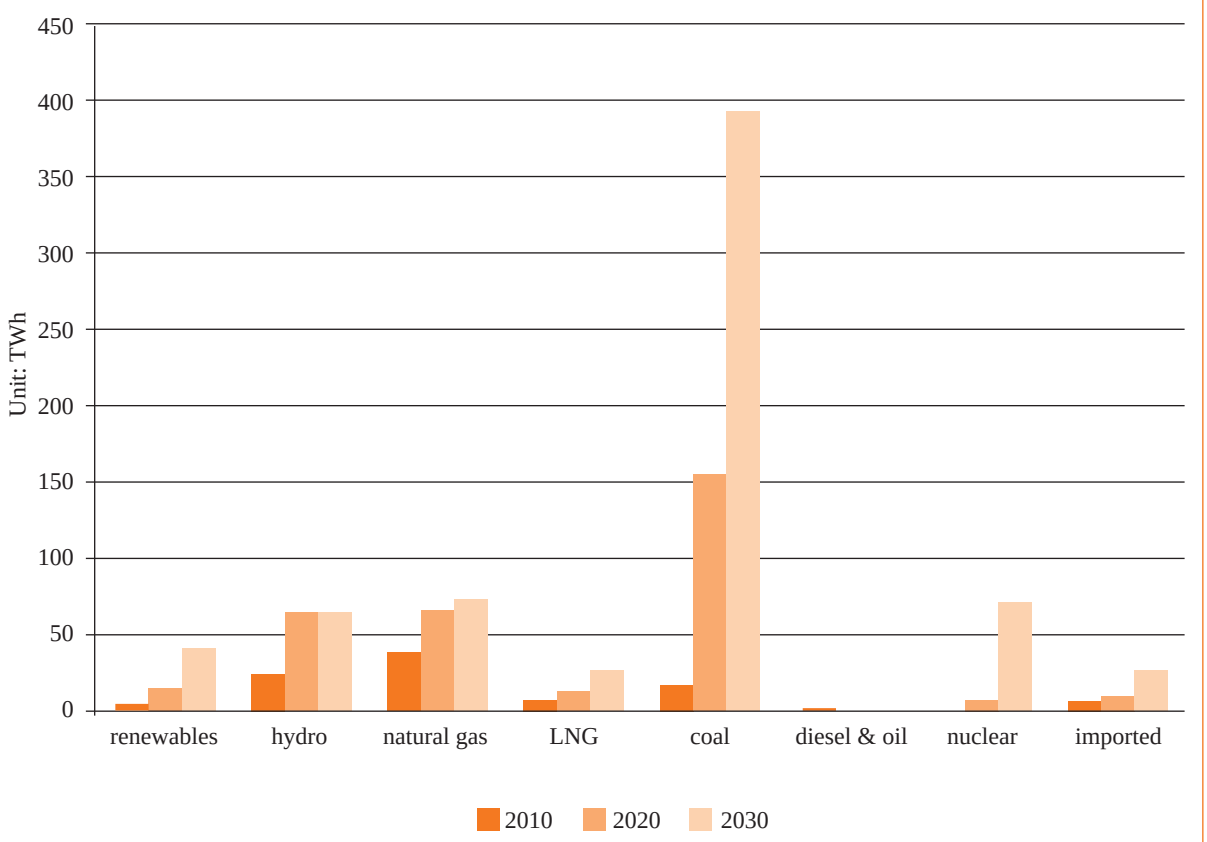
At the city level, Quy Nhon has a number of initiatives focused on climate change mitigation and adaption. In 2010, with the assistance of the Asian Cities Climate Change Resilience Network[2] (ACCCRN), Quy Nhon developed a climate change resilience plan (ACCCRN 2010). This included a hazards, vulnerability and capacity assessment (HVCA), household surveys and CBDRM training courses for city officials run by Challenge to Change (2009). The HCVA, together with other climate vulnerability studies, has enabled city authorities to develop a resilience plan. While the resilience of the energy system is mentioned in the plan (e.g. damage to electricity poles and power cuts), there are no specific actions to address the resilience of the power network. The HVCA demonstrated that some groups, particularly women, small-scale producers and fishermen, were especially vulnerable to disasters and the risks of climate change. However, while special attention will need to be paid to these vulnerable groups to help them to adapt to climate change, they have been neglected in the literature. A Climate Change Coordination Office (CCCO) has also been established to coordinate climate change adaptation and mitigation initiatives across Quy Nhon. The CCCO involves both local stakeholders and external agencies, and supports city authorities in the promotion of resilience to climate change.

2 *The ACCCRN is funded by the Rockefeller Foundation and supported by MoNRE as part of the NTP-RCC process.*

2.5 Energy policies

The Vietnamese energy system is characterised by high growth, with energy demand growing at 10 per cent per year (Nguyen *et al.* 2012a). Between 1990 and 2010, energy consumption in all sectors increased dramatically, but particularly in the industrial, transport and residential sectors. In the industrial sector, this period witnessed an eight-fold increase in energy consumption. There was a seven-fold increase in energy consumption in the transport sector, from 1412 million tonnes of oil equivalent (MTOE) to 11,139 MTOE. The residential sector's energy consumption similarly increased, although at a slower rate: it increased by 12 per cent in 1990–2010 (Nguyen *et al.* 2012a). At present, although coal dominates electricity supply, hydropower and natural gas are also important energy sources. Future supply is expected to be met largely through coal (see Figure 1).

Figure 1. Changes in power production by major power sources



Source: UN-Vietnam (2013)

The future energy-supply systems for Vietnam will become less stable. As shown in Figure 1, Vietnam is expected to become increasingly dependent on coal to meet its energy demands. Limited domestic coal production means that much of the coal will be imported (Ho 2011; Prime Minister's Office 2011c). As a result, electricity prices are expected to increase. As climate change intensifies, changes in precipitation and water availability are expected to have an impact on energy supplies, particularly on hydropower plants (Ho *et al.* 2013). Indeed, hydropower plants have already been affected by falling water levels in reservoirs. In addition, increased temperatures will lead to a decrease in the efficiency of transmission (Hammer *et al.* 2011).

Although Vietnam is increasingly dependent on imported coal, climatic and geographical factors mean that the country has considerable renewable energy potential. For example, one study estimates wind energy potential at 10,000MW, equivalent to 13.3 per cent of the power-generation capacity installed by 2020 (Prime Minister's Office 2011c). Vietnam also has high solar energy potential, particularly in the Central and South regions, which have annual average radiation of 2.74–5.37 kWh/m2/day (Nguyen *et al.* 2012a).

In Vietnam, electricity policy and planning are based on the 2005 Law on Electricity, which was amended in 2012. The function of this law is:

> … *the development of national power, including a detailed programme for the development of power sources, developing the power grid, the grid links with countries in the region, development of rural electrification, development of new energy sources, renewable energy and other related content* (Vietnam National Assembly 2012).

Based on this law, a National Energy Development Strategy was developed in 2007. The strategy, which contains detailed provisions for the period up to 2020 and an outlook to 2050, aimed to increase the share of renewable energy (excluding hydropower) from around 1 per cent in 2007 to 5 per cent in 2020 and 11 per cent by 2050 (Prime Minister's Office 2011b). Based on this strategy, the VII Power Development Plan (PDP VII) was developed in 2011. The PDP VII was approved by the Prime Minister in July 2011 and includes renewable energy targets of 4.5 per cent by 2020 and 6 per cent by 2030. The targets in the PDP VII are therefore lower than those put forward in the strategy, which may also be considered modest given Vietnam's renewable energy potential. The inconsistency in these two renewable targets exists due to a lack of coordination between relevant agencies and the different approaches adopted by the two policies. Although the potential for waste, biogas and solar energy sources was not specifically mentioned in the PDP VII, the plan does state:

> *Power generated from renewable energy sources (wind turbines, solar, biomass etc.) are prioritised to develop quickly in order to increase the rate of power generation from renewable energy sources* (Prime Minister's Office 2011c).

Furthermore, since the growth in energy demand is likely overstated, the energy-demand projections in the PDP VII are themselves questionable (Institute of Energy Science 2013).

In addition to these policies, which aim to increase the share of renewable energy in Vietnam's energy mix, operators of renewable energy plants may benefit from other policy measures (Nguyen *et al.* 2012a). Examples of benefits for investors include exemptions on import tax for goods that cannot be produced locally, low-cost loans during the project development phase, and tax exemptions during the operational phase. While the regulation[3] stipulates that renewable energy project developers and manufacturers of renewable energy technologies should be prioritised in accessing financial resources, which includes preferential interest rates and terms, in reality it is difficult to access these funds. This is because there are limited financial resources available whilst there is a long list of priority sectors. Likewise, the preferential import tax rate has yet to be applied due to a lack of implementation guidance. As a result, many developers pay normal import taxation rates then apply for a refund (Nguyen *et al.* 2012a).

Several issues must be addressed before Vietnam's energy policy ambitions may be realised. First, planning is centralised and as a result less-flexible, large-scale solutions are favoured. It is therefore rare that the energy needs of regional actors and other stakeholders are taken into consideration. Second, as discussed, most of the growth in energy demand is expected to be met through coal-fired power plants. This emphasis on coal will generate significant GHG emissions, undermining efforts to address climate change. Third, enforcement of power development planning is weak, which means that it is unlikely that the renewable energy targets outlined in the PDP VII will be met (GreenID 2013). Finally, none of the energy policies currently consider the risk from disasters. Despite these concerns, there have been some energy successes, most notably rural electrification policies. The share of households with access to electricity has increased from just 2.5 per cent in 1975 to more than 96 per cent of households by 2011 (World Bank 2011).

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3 *Decree No. 151/2006/ND-CP dated 20 December 2006 by government on state investment development credit and export credit; Decree No. 106/2008/ND-CP dated 19 September 2008 by the government on amendments; supplements of some articles of Decree No. 151/2006/ND-CP dated 20 December 2006 by the government on state investment development credit and export credit.*

2.5.1 Vietnam's energy market

Another barrier to the development of a more resilient energy sector is the structure of the Vietnamese energy market. While the national government supports renewable energy development, a key barrier is the bargaining power of Electricity of Vietnam (EVN) (Nguyen *et al.* 2012a). EVN, a state-owned enterprise, is Vietnam's largest power company. The company is both vertically and horizontally integrated. It is the only enterprise which manages the Vietnam energy market in the processes of energy generation, transmission and distribution and is involved in both importing and exporting energy. EVN also invests in and manages the finance of power-related projects and manages, operates, maintains and upgrades the electricity equipment and power works (transmission, substations etc.).[4] EVN has to buy all the electricity that is supplied to the grid. As the only buyer in the country, EVN is able to act as a monopsonist. To highlight the control EVN exerts over the Vietnamese energy market, Nguyen *et al.* (2012a) use the case of Ly Son Island. In 2007, in response to a call for investment from Quang Ngai People's Committee, a wind-diesel hybrid system was proposed by two German companies. The expected production cost was VN$ 3000 (US$ 0.14) (Clean Energy Joint stock Company 2011). However, EVN only offered VN$ 760 (US$ 0.036) per kWh, rendering the project unprofitable. Cases like these discourage investment from (foreign) investors in renewable energy. For certain renewable energy technologies, such as solar panels, micro-wind turbines or small hydropower, it will be necessary to negotiate power purchase agreements with EVN in order to sell any excess electricity to the grid or to be allowed to transfer electricity from one grid connection to the other. However, as the case of Ly Son Island illustrates, the low price paid by EVN affects the profitability of these projects. As a result, the project was stopped after the investors and EVN failed to reach any common power purchase agreement. Although there is a feed-in tariff for wind energy, the rate (VN$ 1614 or US$ 0.075) has been set too low, especially in comparison with other countries in the region.

At present, market structure is a barrier to the uptake of renewable and decentralised energy sources, although present and future developments are likely to lead to reforms in Vietnam's energy market. For example, the 2012 Green Growth Strategy highlights efforts to increase energy efficiency and to foster renewable energy production, although specific targets are not mentioned. Furthermore, this strategy proposes the removal over time of subsidies for fossil fuels. As the price of energy for suppliers and consumers becomes closer to the market price, this will create a level playing field for alternative sources of energy. In the longer term, the power sector might be 'equitised', which means that the state-owned enterprises would be reformed and become joint-stock companies (Nguyen 2012).

2.5.2 Local energy initiatives

In addition to energy policies at the national level, there are several energy campaigns and subsidy schemes aimed specifically at Quy Nhon. Some of these schemes are city-wide, whereas others target particular provinces and/or regions within Vietnam. These are described briefly here:

- **Household Energy Saving (2013).** This project run by EVN aimed to encourage electricity savings during the dry season of 2013. Households were encouraged to save 10 per cent of electricity over a period of three months, compared with the same period in 2012. The project was conducted in close cooperation with organisations including labour unions and women's unions, which held awareness-raising campaigns. EVN ran a website on electricity-saving measures. This project is being run in thirteen cities in Central Vietnam, of which Quy Nhon is one.
- **Solar water heaters (2011–2015).** Also run by EVN, this nationwide programme aims to promote the use of solar water heaters in households. The programme also aims to raise awareness amongst communities about how to effectively save electricity. Every household that installs a solar water heater, rather than an electric water heater, receives financial support to the sum of VN$ 1.5 million (US$ 70.50). Solar water heaters are only sold by companies approved by EVN. Solar water heaters, however, require a significant upfront investment, and the programme probably does not reach all the target groups in our research.

4 *See* www.evn.com.vn

- **The Biogas Programme for the Animal Husbandry Sector in Vietnam**[5] **(2003).** This project had the dual aim of protecting the environment whilst alleviating poverty. It funded by the Vietnamese and Dutch governments. The project was implemented by the Department of Livestock Production (DLP) under the Ministry of Agriculture and Rural Development (MARD) as well as SNV Netherlands Development Organisation. By the end of 2012, 125,000 biogas plants had been built under the project. Training was another key component of the project, with training provided to 953 technicians and 1505 biogas construction teams; workshops were also held for biogas users.
- **Green Agricultural Production, 2013–2018.** This ADB-funded project aims to support low-carbon agriculture in ten provinces, including Binh Dinh. The overall objective of the project is to contribute to the development of sustainable, efficient and environmentally friendly agriculture. This involves the use of agricultural waste, which may be used for household and local energy production.

In addition, electricity companies in Binh Dinh have implemented monitoring and maintenance activities for electricity infrastructure, which includes electricity poles, loading stations and substations in dangerous areas (i.e. areas affected by soil erosion and storm damage). For example, the Binh Dinh Electricity Company, together with local authorities, agencies and people, has been working on disaster-prevention measures such as cutting down larger trees to protect the safety of the electricity grid (interview with N.V.T, DOIT, Quy Nhon City – see Appendix 3).

However, we have observed several key gaps in these programmes, which are mostly focused on energy efficiency and GHG emission reductions. First, there have been delays in actions and investments to improve the electricity infrastructure, which would ensure people's safety during the stormy season, particularly in disaster-prone areas including coastal areas. Second, there has been a lack of attention paid to the poorest households who should be able to access low-cost energy models such as improved cook-stoves, solar lanterns etc. At present, renewable energy programmes are aimed at better-off households who can afford the costs of the models. However, this might be the responsibility of local authorities, rather than the electricity companies themselves. Third, little attention has been paid to other manufacturing or processing enterprises in their efforts to reduce their electricity costs as part of their production costs, through the use of energy-saving technologies for fishing, boats and production workshops. Finally, the biogas programme does not target poorer households who have small amounts of livestock and who live along the coast; instead, the focus has been on agricultural areas.

2.5.3 Small-scale renewable energy technologies

Small-scale renewable energy (SSRE) technologies have emerged as alternatives to grid-supplied electricity and as a means to tackle energy poverty. SSRE can also help to address macro- and micro-scale energy-security concerns, diversifying national and local economies against fossil-fuel price rises. Table 1 lists the key characteristics of small-scale renewable energy technologies: solar home systems, residential wind turbines, biogas digesters and gasifiers, microhydro power and improved cookstoves.

5 *For more information see: www.biogas.org.vn/english/Home.aspx*

Table 1. Overview of renewable energy technologies for addressing energy poverty

Technology	Size	Fuel source	Primary energy services	Cost (levelised US cents/kWh)
Solar home systems	10–150 Watt peak	Sunlight	Lighting, communication (radio and mobile phones), television, small electrical appliances	40–60
Biogas digesters and gasifiers	6–8 m^3	Biogas from waste	Cooking and heating	8–12
Household wind turbines	0.1–3 kW	Wind	Lighting, communication (radio and mobile phones), television, refrigeration, larger electrical appliances	15–35
Microhydro dams	5 kW to 10 MW	Water	Lighting, communication (radio and mobile phones), television, refrigeration, larger electrical appliances	5–30
Improved cooking stoves		Biomass	Cooking and heating	

Source: Sovacool and Drupady (2012)

There are many benefits of SSRE systems, including improved living standards, livelihood opportunities, independence from fuel availability, reduced fossil and traditional fuel consumption, enhanced public health, and climate change mitigation and adaptation. By displacing traditional fuel sources, including biomass, charcoal and manure, SSRE technologies also deliver health and safety benefits. Furthermore, as SSRE systems are located closer to the site of demand, distribution and transmission costs as well as energy and capacity losses are reduced (Sovacool and Drupady 2012). However, SSRE technologies typically involve high initial investment costs, a barrier often exacerbated by a lack of dedicated financing mechanisms. Furthermore, the small and dispersed nature of these technologies does not facilitate economies of scale (Hossain Mondal *et al.* 2007). Studies have shown that biomass-based power generation emerges as the lowest cost option, while solar is the most expensive (Narula *et al.* 2012; see also Table 1). Table 2 provides a short overview of the different techniques and their main advantages and disadvantages.

Table 2. Advantages and disadvantages of SSREs

Technology	Advantages	Disadvantages
Solar home systems (SHS)	■ Flexibility ■ Easy to install and maintain ■ Little training required ■ Improved health and safety (Martinot *et al.* 2001; Obeng *et al.* 2008) ■ Can run small appliances, such as TVs (Wamukonya 2007)	■ Expensive systems, therefore mainly used by higher-income households (Jacobson 2007). Use for poverty alleviation is thus limited ■ Vulnerable to theft (Sovacool *et al.* 2011) ■ Not suitable in high-latitude or storm-prone areas ■ Only provides a small energy supply, might therefore not be compatible with demand (Sovacool and Drupady 2012)
Biogas	■ Can be applied at different scales (from one household up to a 1000 families) ■ Reduced reliance on traditional energy systems ■ Contributes to manure- and waste-management strategies	■ Biogas plants are permanent structures that cannot be moved ■ A sufficient supply of waste is required; therefore the biogas installations are mostly built by wealthier families that own animals ■ Can leak methane when poorly built ■ Untreated slurry can pollute the water ■ Social and cultural barriers
Micro-wind	■ Favourable because of the availability of wind resources, the scalability and expandability of the technology, and competitive energy pricing (Louie *et al.* 2012) ■ Competitive in coastal areas ■ Scalability; extra capacity can be added with increasing demand	■ Assessment of the wind resources is needed ■ Training for maintenance is needed ■ Costs for maintenance are high ■ High costs per kWh (Louie *et al.* 2012) ■ Supply chains may be limited ■ Awareness among people may be limited
Microhydro	■ Can also provide mechanical energy ■ Easier, safer, cheaper and cleaner than diesel generators ■ Local people can be trained to maintain the system ■ Minimal social and environmental impacts (Gippner *et al.* 2013)	■ Continuous and dedicated maintenance needed ■ Breakdown or maintenance leads to discontinuation of power supply ■ Communication between upstream and downstream communities required ■ Unpredictable river flows can impede production – this may be problematic as the impacts of climate change intensify (Sovacool and Drupady 2012; Gippner *et al.* 2013)
Improved cookstoves	■ Reduced fuel consumption compared to traditional open fires (Ruiz-Mercado *et al.* 2011) ■ Improved air quality and reduced air pollution ■ Generate more heat and have shorter cooking times ■ Quick to install, durable and affordable	■ May not be compatible with cooking habits ■ Families are still reliant on biomass (Ruiz-Mercado *et al.* 2011; Sovacool and Drupady 2012)

Which SSRE technologies are appropriate in a given context will depend on a number of factors, including the spatial distribution of households, energy service needs, variability in demand, income levels, local energy resources and ease of maintenance. Furthermore, the opportunities, challenges and barriers to the adoption and use of SSRE systems will be context specific. Acknowledging the importance of context Sovacool and Drupady (2012), in their comprehensive analysis of ten case studies of SSRE initiatives in Asia, identify twelve lessons for the success of initiatives to expand energy access. These are: net beneficial energy access, appropriate technology, community commitment, awareness raising, after-sales service, income generation, institutional diversity, affordability, capacity building, flexibility, monitoring and evaluation, and political support. While all of these are clearly relevant to this research project, below we provide more detail on those issues of particular interest.

First, technologies must be appropriate to the local context. This means that the SSRE technologies chosen should be service- rather than technology-oriented. Feasibility studies can help to identify consumer segments, determining energy demand and ensuring that technologies match quality and scale to the energy service desired. Also, the physical/ environmental situation should be taken into account as this can have an impact on the productivity of the technologies.

Appropriate technology relates to the second lesson, that of community commitment. Successful programmes involve local stakeholders, including households, communities, entrepreneurs and service- and maintenance-providers. Community ownership, operation, in-kind contributions and participatory decision-making of SSRE systems can enhance their success by ensuring that end-users are active participants rather than passive consumers. This can be linked to training on maintenance of SSREs. Awareness-raising is also therefore important to ensure that consumers are aware of the benefits of renewable energy technologies and are involved from an early stage of the programme (Hossain Mondal *et al.* 2010; Gippner *et al.* 2013). The establishment of and support for enterprises that construct and sell SSRE technologies can be important, as well as the provision of financial assistance to overcome the initial cost hurdles e.g. through microcredit and energy service companies (Hossain Mondal *et al.* 2010). Finally, effective programmes benefit from political support and an appropriate institutional and regulatory environment. This may include a dedicated/ experienced implementing agency, integration with other policies and regulations, or a policy champion (Hossain Mondal *et al.* 2010). SSRE programmes will benefit from political leadership, policy harmonisation and financial and other incentives (Sovacool and Drupady 2012).

These lessons highlight the socio-technical nature of acceptance or rejection of SSRE technologies. The focus should not only be on ensuring the standardisation and quality of a technology, but also on getting the price signals and financing right, on responding to cultural values and expectations, raising awareness, and building institutional capacity.

Table 3 details the existing capacity of different renewable energy sources in Vietnam, as well as the development targets as mentioned in the PDP VII. It should be noted that the potentials for most of these energy sources are higher. For instance, for wind energy, the potential is expected to be around 10,000 MW (GIZ/MOIT 2011).

Table 3. Existing and target capacity of renewable energy sources in Vietnam based on the PDP VII

Renewable sources	Existing capacity (MW)	Target capacity (MW)	
		In 2020	In 2030
Wind	1	1000	6200
Hydropower	9200	17,400	
Microhydro	121	1800	5700
Biomass	150	500	2000
Waste	2	N/A	N/A
Biogas	2	N/A	N/A
Solar	2	N/A	N/A

Source: Ipsos Business Consulting (2012)

3 Researching energy resilience

To address the research gap in the energy resilience of climate-vulnerable households, GreenID and Challenge to Change carried out research in Quy Nhon, Vietnam. Although the city has an action plan for climate resilience, energy issues were not identified and were not seen as a matter of concern (Tien *et al.* 2010). As discussed, the development of disaster-resilient energy systems is of critical importance, particularly for marginalised groups. In the next sections we describe the approach taken to meet the project objectives. These are to assess energy demand, energy status and access to resources amongst vulnerable groups and to identify suitable alternative energy solutions for them, as well as the barriers and opportunities for the uptake of these solutions. Finally, our research aims to evaluate the role of energy provision in disaster-preparedness planning.

3.1 Research location: Quy Nhon

Our research focuses on Quy Nhon, the capital city of Binh Dinh Province. In 2011, the city had a population of 280,000, which was expected to increase to 500,000 over the next decade (Dinh *et al.* 2011). The city covers a land area of 286km^2. Its location on the central coast of Vietnam has consequences for some of the climate challenges the city is likely to experience. The city is comprised primarily of low-lying coastal land with mountains running alongside the entire western edge of the city.

Table 4 provides some socio-economic data on Quy Nhon City and the Binh Dinh Province. In terms of the economy of Quy Nhon, trade and services account for 45 per cent, followed by industry and construction (35 per cent), and agroforestry and fisheries (20 per cent). Compared to Binh Dinh Province, agroforestry and fisheries are the dominant sectors in Quy Nhon City.

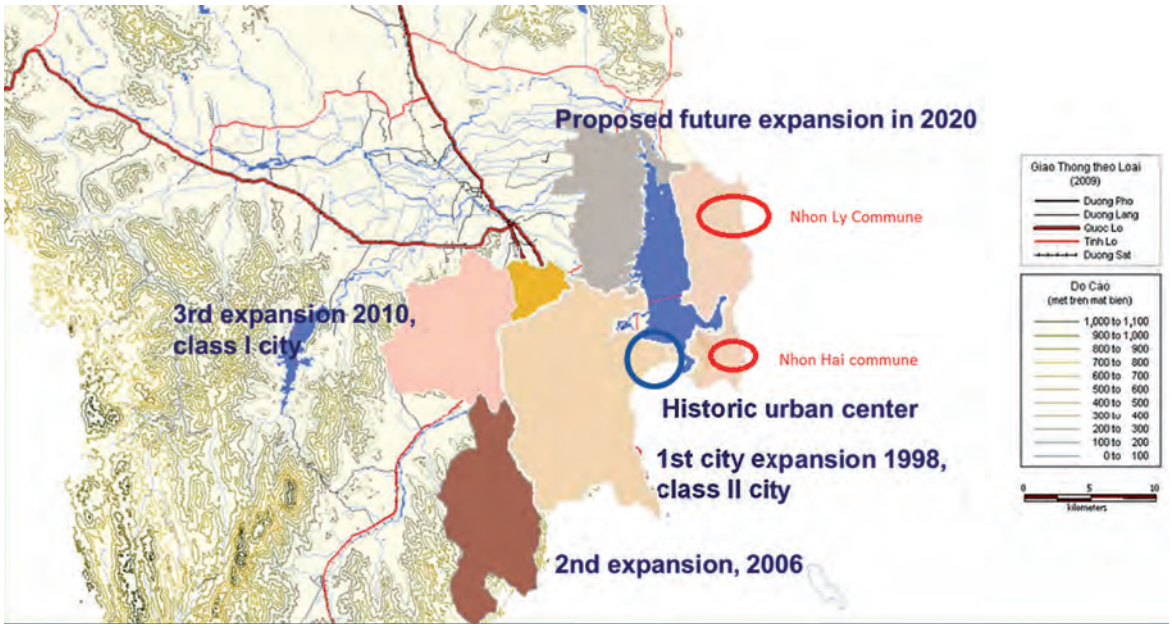
Table 4. Socio-economic data for Quy Nhon City and Binh Dinh Province

	Quy Nhon City	Binh Dinh Province
Area (km^2)	286	6039
Population (2007)	268,000	1,578,890
Population density (person/km^2)	938	235
Urban population (%)	21	24
Poverty rate (%)	4.5	11.35
Key economic sectors (%)		
Agroforestry and fisheries	20	7
Industry and construction	35	43
Trade and services	45	50

Source: Challenge to Change (2009)

Since 1986, Quy Nhon has undergone three administrative expansions (see Figure 2). In March 2010, as the city expanded for the third time, Quy Nhon was upgraded to a Class I city[6] at the provincial level. Further expansion of the city is proposed for 2020.

Figure 2. Expanded administration areas of Quy Nhon (Huynh 2013)



6 *Vietnam urban cities are categorised into six types including special urban cities (such as Hanoi and Ho Chi Minh City); and Class I to IV urban cities. The class to which a city belongs is determined by a number of factors such as population, population density and the percentage of people that are not employed in the agricultural sector. These criteria are stipulated in Decree 42/2009/NĐ-CP by the prime minister.*

The percentage of the population of Quy Nhon considered poor is relatively high: the five communes with the highest poverty rates are Phuoc My (14 per cent), Nhon Chau (12 per cent), Nhon Hai (8 per cent), Nhon Ly (7 per cent) and Nhon Hoi (7 per cent) (Nguyen 2013). An urban household is considered 'poor' when the average household income is less than VN$ 500,000 per person per month (US$ 23.50) (Prime Minister's Office 2011a). Households are classified as 'almost poor' when the average income per person in the household is VN$ 500,000–650,000 per month. Many of those living in poverty in Quy Nhon work in small-scale seafood production and fisheries (Nguyen 2013).

Within Quy Nhon, we focused our research on the communes of Nhon Hai and Nhon Ly. These are two coastal communes, which are particularly affected by typhoons and tidal surges. The first commune, Nhon Hai, has an area of 12.13km^{2a}nd a population of 6139 inhabitants. This commune includes four villages: Hai Bac, Hai Nam, Hai Dong and Hai Giang. People are principally employed in fishing and seafood processing and production. The second commune, Nhon Ly, is located to the northeast of Quy Nhon City and has a population of 9002. This commune is comprised of four villages of Ly Hoa, Ly Luong, Ly Hung and Ly Chanh. Almost 7 per cent of the households in Nhon Ly are classified as 'poor' (Nhon Ly People's Committee 2013). As with Nhon Hai, the main industries are fishing and seafood processing, and also animal husbandry.

3.2 Study approach and methodologies

To investigate the relationship between energy resilience and climate change in Quy Nhon, three data collection methods were used:

- A household questionnaire
- In-depth interviews, and
- Focus group discussions.

In order to collect baseline data on the socio-economic characteristics and energy use in households in Nhon Ly and Nhon Hai, we first conducted a household survey. We used a convenience sampling approach wherein participants were recruited on the basis of their accessibility. Although the research was focused on vulnerable groups (i.e. poor women, fishermen and small-scale producers), we chose to adopt this approach because we wanted to be sure that we reached the target groups. Chairmen from two communes acted as gatekeepers, facilitating access to potential participants and providing insights into local community dynamics. The survey was carried out by members of the research team through face-to-face interviews. The respondents' answers were filled in by the research team members. The questionnaire was comprised of seven sections:

- Section A focused on the socio-economic characteristics of the household
- Section B explored current energy use for different end uses
- Sections C and D provided information about current energy production and the potential for renewable energy production, and
- Sections E, F and G investigated respondents' knowledge about climate change, the impacts of disasters on their day-to-day lives and energy consumption.

A total of 100 questionnaires were undertaken; 60 per cent from Nhon Ly and 40 per cent from Nhon Hai. The survey can be found in Appendix 2.

The questionnaire was supplemented by focus group discussions, which aimed to explore in greater depth participants' experiences of climate disasters during the past decade. Participants were recruited in collaboration with the chairman of each commune. A total of five focus group discussions were held:

- Two with on-shore fishermen, Nhon Ly and Nhon Hai
- Two with small-scale seafood producers, Nhon Lyand Nhon Hai, and
- One with poor women, Nhon Hai.

The focus groups were facilitated by Challenge to Change and GreenID, and lasted for approximately one hour. Each group had between five and eight participants. In the focus group discussions, participants' energy use and the impacts of disasters on people's day-to-day lives, with a focus on the impacts on energy, was probed in more detail. In the seafood-processing groups, we also explored how disasters such as typhoons, floods and heat waves affected different parts of the production process. A further question explored whether participants were aware of any initiatives to promote small-scale renewable energy and energy efficiency amongst households.

Finally, to investigate the perspectives of other stakeholders, we carried out thirteen in-depth interviews. All interviews were conducted by members of the research team in July 2013. Interviews were held with representatives of people's committees, government officials, NGOs and mass organisations such as the Women's Union and Red Cross (a complete list of interviewees may be found in Appendix 3). We selected these organisations because they are state agencies or organisations directly involved in promoting resilience to climate change (e.g. the CCCO) and energy policies (e.g. Department of Industry and Trade (DOIT)). These interviews aimed to provide us with a greater understanding of policies for climate change, energy and disaster preparedness. Appendix 4 contains a sample interview protocol for these interviews.

In addition to the data-collection methods described above, the research team also played a simulation game with participants in a workshop. Mayer *et al.* (2010) described a simulation game as:

> *[An] experimental, rule-based, interactive environment, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game.*

The workshop was held in the Red Cross office for Binh Dinh. There were 30 participants, including representatives from the two communes studied and provincial governmental officers.

The aim of the simulation game was to raise participants' awareness of how an energy system could be made more resilient, demonstrating that a resilient system could also reduce energy bills. Facilitated by GreenID, participants were provided with a list of energy appliances such as improved cookstoves, solar water heaters, solar panels and diesel generators (see Appendix 5). Information about the different energy appliances was provided on the cards and explained to players. The rules of the game explained that participants had to seek a good strategy to invest in renewable energy models in different scenarios. The game had ten rounds, each with different assumed scenarios. For example, in some scenarios energy prices increased, while in others disasters occurred more frequently. Participants were divided into three groups: fishermen, small-scale producers and poor women. Relevant indicators such as how much income or energy costs reduced or increased once the group had chosen different energy models and appliances were presented to all participants. Players calculated how much money they had left after each round, after it was decided randomly whether a disaster would happen. A disaster meant not only lower incomes, but also higher costs for energy. The winners of the game were the group with the most money left.

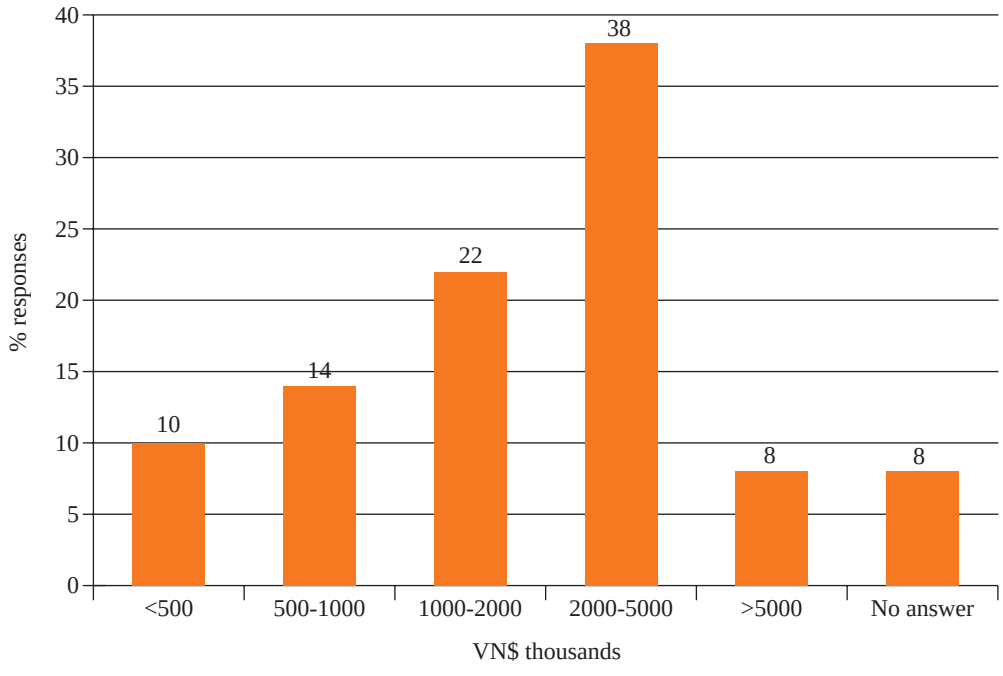
4 Results

In the following section the results of the survey, focus group discussions and interviews are discussed. First, we discuss the socio-economic situation, followed by the energy potential and demand. We then go into detail on climate change and disasters, discussing climate change, impacts from disasters and coping mechanisms, and energy-related impacts. Finally, we discuss disaster risk reduction policies and coping and adaptation measures.

4.1 Socio-economic situation

Of the 100 completed questionnaires, 62 respondents were men and 38 were women. Respondents were principally employed in fishery-related labour (56 per cent), aquaculture (12 per cent) or seafood processing (9 per cent); other occupations accounted for 20 per cent of participants.

Figure 3. Monthly household income in Nhon Ly and Nhon Hai Communes



From Figure 3, it can be seen that the majority of households in the two communes have a monthly income of VN$ 2–5 million (US$ 100–240). Meanwhile, 10 per cent of the households live on less than VN$ 500,000 per month (US$ 23), and are thus below the poverty line. Another 14 per cent of the households live on less than VN$ 1 million (US$ 47), which equals approximately US$ 1.50 a day. The percentage of households with an income of above VN$ 5,000,000 (US$ 240) is quite low at 8 per cent. When comparing the number of people in households with the income per households, it becomes clear that 40 per cent of the households are poor (less than VN$ 500,000 per person, as per the official definition), and that around 35 per cent of the households are close to the poverty line (less than VN$ 650,000 is considered to be almost poor). It must be borne in mind that respondents were asked to report an income range and incomes may vary over time, for example because of seasonal influences. This study thus reflects the concerns and opinions of the most vulnerable people in Nhon Ly and Nhon Hai (which have an average poverty rate of at around 8 per cent) on the impacts of disasters on energy supply.

4.2 Energy consumption

All the surveyed residents of Nhon Ly and Nhon Hai were connected to the grid. The majority (73 per cent) of the households surveyed have a monthly energy bill of VN$ 100,000–300,000 per month (US$ 4.70–14.10). Only 17 per cent spent less than VN$ 100,000 on electricity. For some poor households – those with an income of less than VN$ 500,000 – the electricity bill accounts for a significant part of their expenditure and as one resident in Nhon Hai commune said, '[the] monthly electricity bill is a burden we have to shoulder'.

In terms of energy services, most participants used compact or fluorescent light bulbs for lighting; only 9 per cent of those surveyed had a solar lantern. Most respondents used gas or electric stoves for cooking; just 9 per cent of households relied solely on a traditional coal or wood stove. Electricity was also used for electrical appliances. Almost all respondents had a television or an electric fan, and 90 per cent had a mobile phone; 57 per cent of respondents had a refrigerator.

Participants were also asked about other sources of energy, such as biogas, solar and electricity. None of the households surveyed used biogas and only one household had a solar water heating system. However, half of those surveyed used diesel, for instance for operating boats, machines or generators; 34 per cent of participants owned a diesel generator. Almost a quarter of respondents spent more than VN$ 13 million per month (US$ 611) on diesel. These respondents were typically employed in fishery-related industries and aquaculture. It is worth noting here that between 2006 and 2013, the price of diesel doubled. Rising energy prices, in combination with depleting fish stocks, has led to a drop in the number of offshore fishermen in Vietnam, according to one off-shore fisherman we interviewed. This may increase the stress on other livelihoods which are either directly or indirectly dependent on fishing (such as sea-food processing).

4.3 Climate change and disasters

A majority (64 per cent) of those surveyed were aware of climate change (see Figure 4). They stated that climate change would lead to more intense typhoons (58 per cent) and higher temperatures (56 per cent). Fewer respondents (37 per cent) were aware that climate change would lead to sea-level rises. Only 7 per cent attributed the cause of anthropogenic climate change to increased GHG emissions. Of those that were aware of climate change, a majority had obtained their information from the media; a few also referred to other organisations (such as the women's union) or the government as a source of information about climate change.

Figure 4. Participants' knowledge of climate change

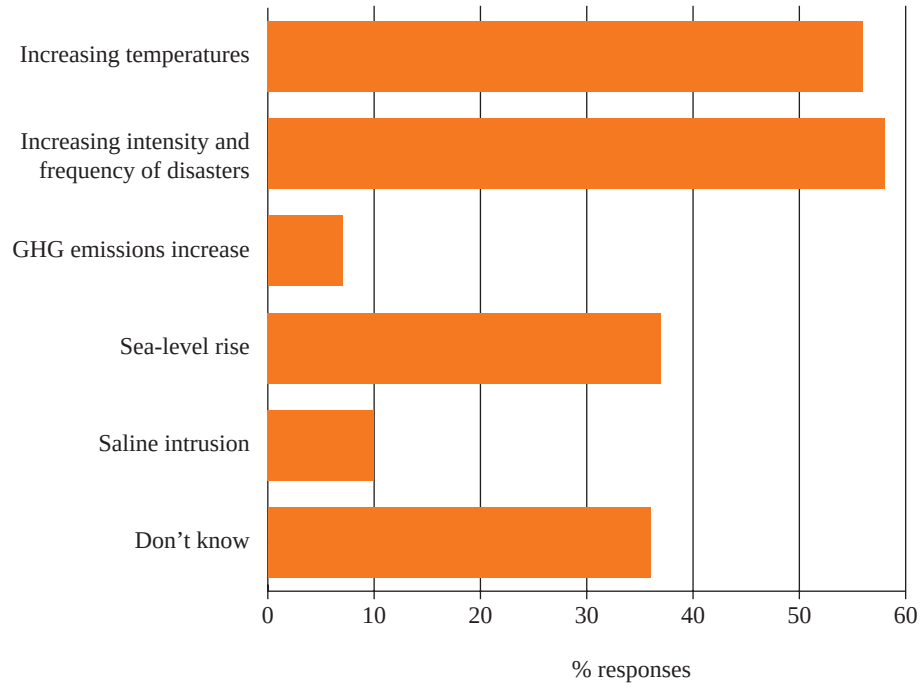
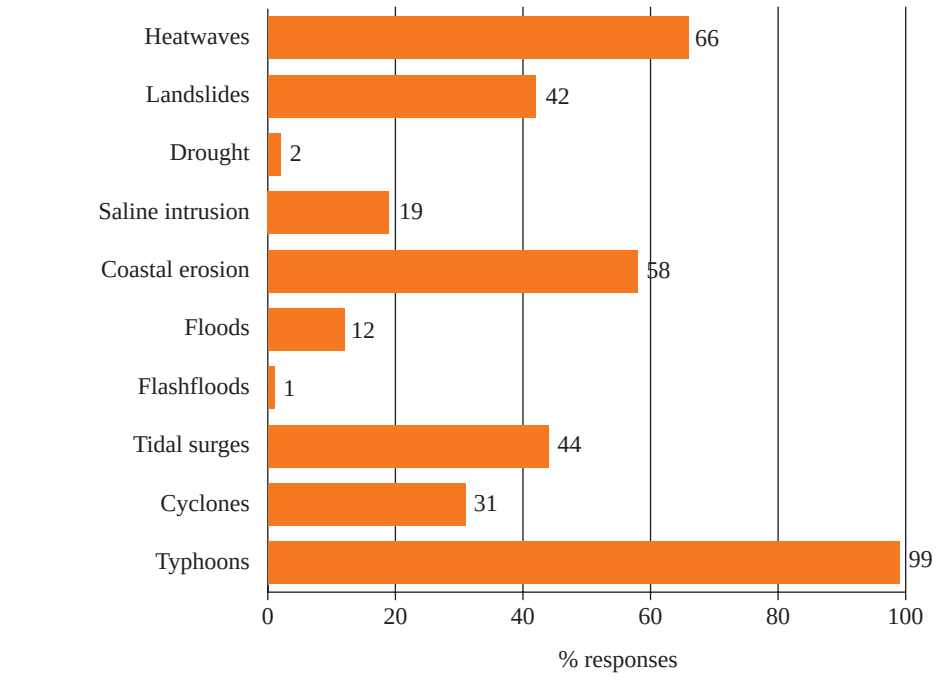
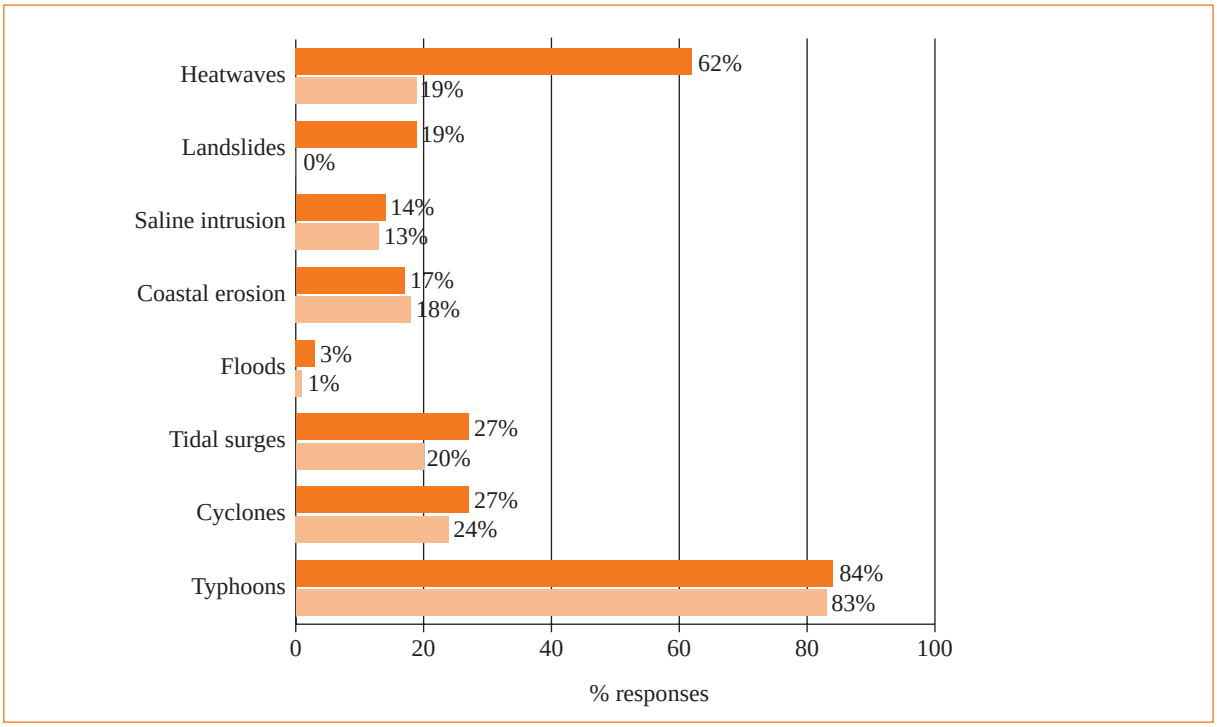


Figure 5. Which type of disaster is your village most exposed to?



The survey and group discussion results show that local people in these study sites already face multiple hazards. When asked which disasters people have to deal with regularly almost all of the respondents mentioned typhoons (99 per cent); this was followed by heat waves (66 per cent), coastal erosion (58 per cent), tidal surges (44 per cent), whirlwinds (31 per cent), floods (12 per cent) and saline water intrusion (19 per cent) (see Figure 5). When these hazards occur is dependent on the season. Participants perceived an increased likelihood of typhoons, coastal erosion, saline intrusion and heat waves occurring (see Figure 6). For example, 84 per cent of respondents thought that typhoons were becoming more frequent, while 83 per cent thought that typhoons were more intense. For heat waves, these numbers are respectively 59 per cent and 62 per cent. Since Nhon Hai and Nhon Ly are located in coastal areas, coastal erosion together with tidal surges and saline intrusion were also mentioned; however, these events are less common than typhoons and heatwaves. These responses echo those discussed in the Climate Change Resilience Plan for Quy Nhon (ACCCRN 2010).

Figure 6. Perceived frequency and intensity of disasters compared to 10 years ago



4.4 Impacts and risks of disasters

Participants were also asked about the impacts of climate disasters on their families, households and communities. Loss of life and injuries were cited by respondents from focus group discussions as one of the most serious impacts of typhoons and whirlwinds, but improved disaster-warning systems had reduced this particular risk. The impacts from disasters particularly affected those who work off-shore, which included both boat owners and workers.

Many of the households in Nhon Ly and Nhon Hai are located along the coastline, leaving them vulnerable to coastal erosion and tidal surges. During the discussion with fishermen from Nhon Ly, it emerged that around 80 houses were on the verge of being swept away. As these houses were located adjacent to beaches, they were particularly vulnerable to coastal erosion and were exposed to typhoons, storms, tidal surges and wind. Similarly, the focus group discussion with fishermen in Nhon Hai Commune revealed that 91 households were in the process of being resettled due to the impacts of

coastal tidal surges. These threats were exacerbated by the poor housing conditions in which people lived. Focus group participants explained that their homes were negatively impacted by heavy rainfall and tidal surges, which led to flooding and threatened the safety of their families. This was particularly important for Nhon Ly, where focus group discussions and questionnaire results revealed that tidal surges had resulted in many homes being flooded. The loss of and damage to key assets such as boats, seafood-processing materials and possessions were also mentioned.

There are considerable knock-on effects from storms, for example in terms of livelihoods. Focus group discussions revealed that off-shore fishermen are more vulnerable to storms than near-shore fishermen. This is because off-shore fisherman typically spend a longer period at sea (over a month), even during the rainy season; conversely, near-shore fishermen decide each day whether to fish and, in the event of a typhoon or storm, can more easily decide to stay at home. Although off-shore fishermen may choose to stay in the harbour during the typhoon season, this reduces their income. Since bigger, off-shore boats require greater investments than smaller boats used for fishing nearer to shore, the economic losses also tend to be much higher. An in-depth interview with a representative of the People's Committee of Quy Nhon revealed that in Nhon Ly there were 254 near-shore and off-shore boats, which ranged from 20 to 90hp. There were 365 boats in Nhon Hai.

Since catches were reduced following a typhoon, seafood producers' incomes were also negatively affected by disasters as they had to pay more for the fish available. Temperature was also an important factor: participants explained that if it was hot, the quality of the fish deteriorated more quickly; conversely, if weather conditions were too humid it would take longer for fish to dry, which also affected the quality of the fish. During hot weather, the smell of waste water became stronger, affecting residents' living environments. These focus groups also described how they were affected by tidal surges and typhoons. For example, because the cookstoves used for seafood processing are located underground (see Figure 7), they were often inundated during floods. In such an event, the only solution was to wait for the flood water to recede.

Figure 7. A cookstove used for steaming fish and other seafood produce, Nhon Ly Commune

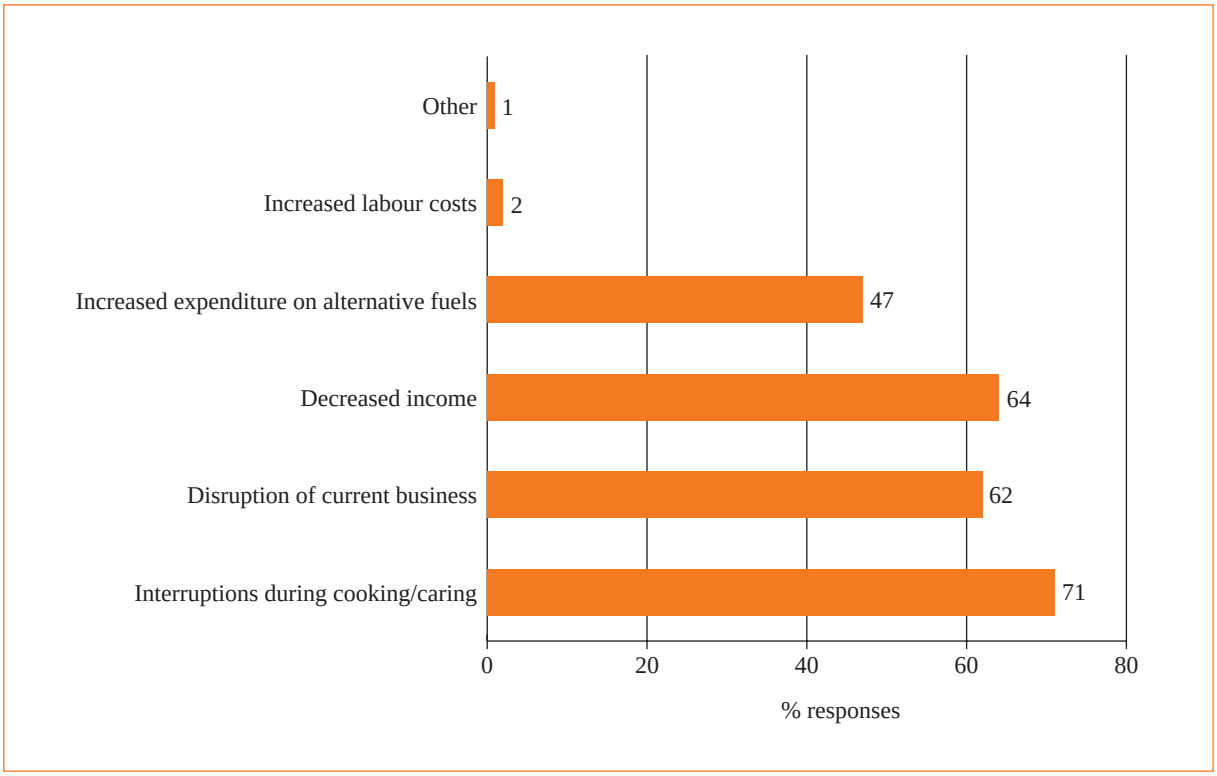
Photographed by Binh Hoang

Through stakeholder interviews and focus groups, negative health impacts were also identified. In the two communes, safe drinking water is unavailable and saline intrusion affects water quality and quantity, with consequences for the health of family members. In such an event, local people need to spend money purchasing water from other sources. Another risk was that of the increased incidence of diseases such as malaria, diarrhoea, skin complaints and fevers, which are more likely to occur during heat waves or in the aftermath of disasters.

4.5 Energy-related impacts of disasters

According to the questionnaire, specific energy-related impacts from disasters cause problems not only for daily living activities such as interruptions during cooking and while caring for families (71 per cent). They also have other economic impacts such as the disruption of business (62 per cent), decreased income due to loss of work or higher production costs (64 per cent) and increased expenses for alternative fuels (48 per cent) (see Figure 8). Focus group and stakeholder interviews also revealed that fluctuations in electrical supply, particularly during the summer months, not only affected people's day-to-day lives, but also the quality of household electrical items. For example, due to an unstable electricity supply, light bulbs, refrigerators and other electrical appliances are more likely to be damaged and more quickly. An interview with a representative of DOIT in Quy Nhon revealed that climate change was likely to affect watercourses such as rivers and particularly during droughts. This would have consequences for Quy Nhon's hydropower plants, potentially leading to power shortages in the city. In such an event, the electricity company has to prioritise and, according to the interviewee, often chooses to cut off power to the communes of Nhon Ly and Nhon Hai in favour of supplying other locales.[7] Damage to power infrastructure also occurs following disasters. According to interviews with local authorities, the electricity company rarely provides any prior warning of blackouts, leaving households unprepared for power shortages.

Figure 8. Energy supply issues experienced



7 *Interview with Deputy Director of DOIT, 25 July 2013.*

There are many examples of impacts on power supply during and after disasters. From the focus group discussions with small-scale seafood producers, it became clear that every stage of production could potentially be affected by disasters. For instance, in the seafood-cleaning stage, participants identified potential problems with the electrical pumps required for obtaining the water to clean the fish. A similar problem arises with waste water, which has to be removed manually instead of being pumped. Disasters may also affect the availability and quality of firewood; a shortage of firewood will also affect prices and therefore the cost of production. Box 2 illustrates the multiple ways in which disasters may affect energy and the consequences for people's lives.

Box 2. People's lives and vulnerability to disasters, Nhon Hai

Mai Thi Bo (64) and Mai Thi Bich Hoa (62) are sisters who make a livelihood by raising pigs. Both sisters complain of having health problems, such as headaches and bone and joint problems. The two sisters have three pigs, having lost one recently, and live in temporary (and thus not legally registered) housing facing the sea. Their house is poorly constructed, with the kitchen separate from the main house, and the sisters are concerned that the house might collapse during a storm. They are aware that raising pigs in the community and close to the sea is not very hygienic, but they have few livelihood alternatives. When a storm or a typhoon comes, they often use an oil lamp for lighting. In the summer, when power cuts are more frequent, they often work in the kitchen, sweating due to the heat, and suffering from the smoke of the traditional biomass stove. They collect firewood and leftover food to provide daily feed for their pigs. If they are unable to collect firewood or other biomass, they have to buy firewood at VN$ 40,000 per bundle (US$ 1.90). A lack of space means they have to store the firewood outside and when it rains their firewood gets wet. As a result it can be very smoky in the kitchen, aggravating the impact on their health.

Figure 9. Representatives of the poor women's group

Photographed by Binh Hoang

Two simple energy solutions would improve their lives. An improved cookstove would use less firewood and reduce their exposure to smoke, while a solar lantern would reduce their need to use oil for lighting. Although the sisters are aware of these technologies, they cannot afford the upfront investment and they have limited access to markets for these alternatives, which are not available in their community.

Working conditions are also negatively impacted by power shortages, and labourers may be required to work harder for longer. Transporting fish is also affected by the absence of electricity, leading to higher transportation costs, because fish has to be transported to Nha Trang for refrigeration, which is more than 200 kilometres away. As a result, small-scale producers have to pay an added production cost (VN$ 20 million or US$ 940). In the event of a disaster, seafood producers described several coping mechanisms. These include the use of diesel generators, hiring additional labour and investing in batteries or better equipment. All of these measures incur additional economic costs.

Figure 10. Cookstove in a household in Nhon Hai Commune

Photographed by Binh Hoang

Figure 11. Biomass storage for cooking, Nhon Hai

Photographed by Binh Hoang

In focus groups with fishermen, participants discussed the impacts of a reduced power supply; this group was particularly affected by typhoons. They described damage to communication systems, which caused distress amongst family members and caused boats to spend more time at sea because it was impossible for rescue teams to reach them. Spending longer at sea affected supplies of fuel and gas for cooking on their boat. Participants described taking extra gas and fuel to sea with them, but this obviously entailed additional expenditure. As with the seafood producers, the fishermen's working conditions were affected by disasters. Participants explained that they often worked for longer under poorer conditions, which has potential health impacts. Where disasters prevented fishermen from working, this had negative consequences for incomes, affecting livelihood security.

In the focus group with women, the key impacts from reduced energy supply mentioned by participants were those that affected their day-to-day activities, such as cooking and caring for family members. Several participants described the negative impacts on supplies of firewood, both in terms of availability and quality. Where stoves were located underground, these were affected by typhoon or tidal surges. Power shortages meant that households were required to use oil lamps or other means of lighting. Finally, the impacts on cooling were mentioned by participants, particularly during heat waves; this has potential health impacts and may affect productivity.

At the level of the commune, the repair of damaged electricity infrastructure was cited as an important disaster response. Because there was no-one in the communes who was able to undertake such repairs, the communes were reliant on the electricity company. However, interviews with the communes' people's committees revealed that these repairs often took a long time to do (one or two weeks) because they had to wait for the electricity company's staff to repair the damage. It was argued by interviewees that other authorities were favoured over their own, with the result that repairs to Nhon Hai and Nhon Ly were not prioritised. In addition to the inconvenience of a prolonged blackout for those living in the communes, it also carried an increased risk of electrocution.

Interviews also revealed that uncertainty about a proposed development was an important barrier, which prevented people from making investments in their homes. They described how 138 households in Nhon Hai were at risk of losing their homes and land to a developer with plans to develop a five-star hotel in the area. Although households had been offered compensation (VN$ 27,000 or US$ 1.30 per $m^{2)}$ it was considered too low and had been rejected by those affected. This uncertainty affected not only people's homes, but also their livelihoods.

4.6 Disaster risk reduction and damage control policies

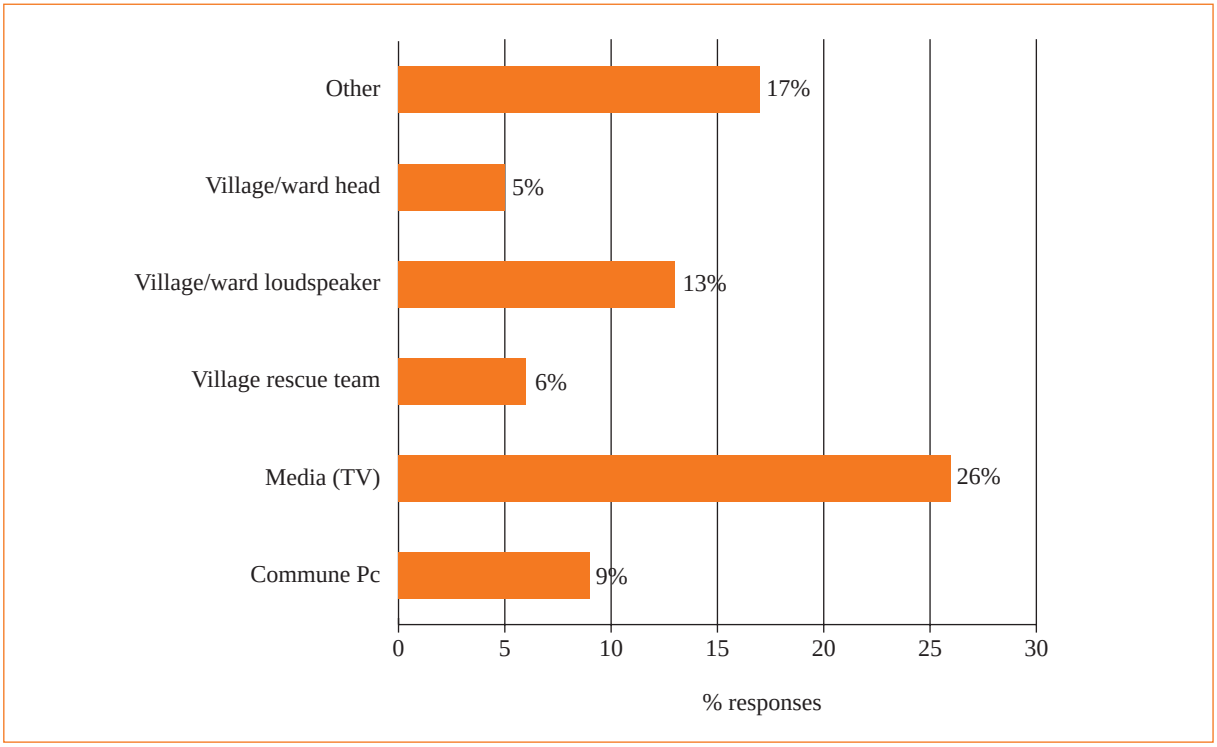
The survey results showed that participants were aware of the national disaster preparedness plan (DPP). They had found out about the DPP from various sources, including commune authorities, village rescue teams, the media and village heads. While the DPP is expected to help build resilience to disasters, only 12 per cent had to date engaged in disaster-preparedness activities.

Interviews with commune authorities revealed a need for more resources to be allocated to disaster risk management activities, including time spent engaging in village-level planning. Although the central government has provided funding for DPP at the commune level, commune authorities are only allowed by the Binh Dinh People's Committee to spend this budget in the event of a disaster.[8] So rather than being used to prevent and adapt to disasters, it is used to respond to the consequences of disasters.

Interviews with representatives of the Binh Dinh Committee for Flood and Storm Control (CFSC) revealed that several plans have been developed by local CFSCs, which also include evacuation exercises in which storm situations are simulated. However, they acknowledged that so far only limited attention has been paid to the impacts of power blackouts on people and businesses. Furthermore, they recognised that an ageing infrastructure in some areas, including the

8 *According to Article 83, Item 5 of Law No 11/2004/QH11 on the Organisation of People's Council and People's Committee of the National Assembly, People's Committees play a role in 'managing and protecting dyke systems, flood resistant works, directing and mobilising human resources to overcome disasters' consequences at locality'. See www.chinhphu.vn/portal/page/portal/chinhphu/hethongvanban?class_id=1&mode=detail&document_id=79677*

Figure 12. Sources of information about disaster-preparedness planning



communes of Nhon Ly and Nhon Hai was a key issue for disaster preparedness. With specific regard to fishermen, one of the vulnerable groups focus on by this research, interviewees at the CFSC stated that the central government had provided support for fishing boats with a capacity of over 90 horsepower (hp); this support was for fuel, communication units and insurance. To date in Binh Dinh, 120 boats have received high-frequency communication units. A further initiative had provided 58 communication units to boats with 20hp or less. These communications units were meant to be used to receive weather forecasts.

4.7 Coping mechanisms and adaptive measures

From the interviews and focus groups it became clear that the current measures implemented by local government, as well as local people in Nhon Ly and Nhon Hai communes, may be classified as coping mechanisms rather than as adaptive measures. This analysis is supported by the findings from the simulation game, which showed that there was initially little awareness of the relationship between energy-provision methods and disasters. In the workshop, participants revealed that they were wary of investing in sustainable energy models. They were unaware of their effectiveness, longevity and long-term benefits and pilot projects were required before decisions to invest in such models could be made. In particular, through the simulation game, the participants tended to select the cheapest energy models and appliances, such as energy saving light bulbs, followed by improved cookstoves. More expensive but higher energy cost-saving models and appliances were rarely selected. The game revealed the importance of the price of energy models and appliances in decision making on investments in alternative energy solutions.

As discussed in Section 2.1, coping mechanisms aim to reduce and minimise the impacts of disasters, rather than to anticipate and prevent losses. This research revealed that participants have developed mechanisms to cope with some of the impacts of disasters, but little has so far been done to adopt measures that may reduce vulnerability to disasters. Table 5 illustrates some of the coping measures identified during focus group discussions that were adopted by the seafood-processing group.

Table 5. Coping measures used by the seafood processing group

Production chain	Energy-related impacts	Coping measures
Fish and other seafood produce	In the event of typhoons or storms, there are fewer boats going out to sea, affecting the amount of stock available for seafood-processing businesses. In hot conditions, the quality of fish and other seafood produce might be quickly affected.	No measures were identified.
Cleaning fish and other seafood produce	Electricity power cuts would affect families' water supplies, impacting on work such as cleaning fish and other seafood produce and therefore affecting its quality.	Using a petrol-run generator, if there is enough investment capital. Investing more in production equipment.
Drying fish outdoors and bringing produce indoors at night	No electricity would mean there is no lighting, making it much harder to bring the fish indoors and therefore people have to work longer hours than usual. Both men and women do this work.	Using batteries. Working longer hours. Employers paying staff overtime results in higher costs.
Steaming fish and other seafood produce	Wet firewood and fewer stocks of firewood result in higher fuel prices leading to higher production costs. As cookstoves are located 1m beneath ground level, any flooding may make it impossible to steam the produce.	Waiting until flooding recedes before continuing work.
Storage of seafood produce	Electricity power cuts during typhoons and storms incur higher transportation costs for produce, including the costs of transporting food to other areas for refrigeration, which also affects quality.	Hiring a vehicle to transport the produce to another location (such as Nha Trang), costing around VN$ 20 million each trip, plus the cost of storage in other locations. The quality of the fish would also be affected.
Dealing with waste from processing	Pumps are normally used to discharge waste water into the sea (which is also a pollution concern for entrepreneurs and local people). The pumps cannot be used during storms or typhoons when there is no electricity.	Employers need to hire more labourers to transport waste water away (normally into the sea), resulting in higher costs.
Human resources	Without adequate lighting while working, production labourers become more tired, many of whom are women. Therefore it is harder to do their work, which also affects their physical health.	Labourers (both men and women) work longer hours in poorer conditions.

With regard to energy technologies and appliances, the use of generators and batteries were mentioned in focus groups, while solar lanterns were used by 9 per cent of survey respondents. Greater uptake of these technologies may help to reduce the negative impacts of a reduced energy supply. In this case, people will be more active in their production activities. Particularly, in the event of a blackout, solar lanterns may be used to provide lighting when washing fish. Some of these technologies, such as solar lanterns, may also provide additional economic benefits due to reduced expenditure on electricity.

Interviews with representatives of the communes' people's committees revealed that piloting technologies is often necessary to convince households of their usefulness. Interviewees explained that once people have experience of using these technologies, they are more likely to purchase them. These findings reveal the need for improved access to alternative improved energy options, which are readily available, affordable and user friendly and specifically to the most vulnerable groups, who could then gradually build up their resilience to climate change effects.

Awareness-raising was also mentioned by stakeholders as critical for both coping with and adapting to climate change. While there have been some efforts made to raise awareness and to provide capacity training for city officials and commune representatives (ACCCRN 2010), further work is required. Interviewees argued that further efforts were necessary to prepare communities for storms, which should also include improved forestry- and water-management practices. However, these interviewees argued that to date these measures have had only limited impact, given the policy measures in place at the commune level that are aimed at repairing the damage.

5 Discussion and conclusions

This study represents an initial attempt to understand the relationship between disasters and energy in Vietnam and the impacts on people's day-to-day lives, particularly those who are most vulnerable due to their livelihood activities and coastal location. Climate change is expected to affect energy supply not only due to an increased occurrence of storms, but also because of extreme temperatures which will affect both energy supply and demand. This research has shown that people are concerned about the impacts of disasters on energy supply, particularly where energy is a key input in their income-generating activities. Disruptions to livelihoods, impacts on sanitation, poor working conditions and increased expenditure on alternative energy sources were all cited by respondents as impacts of disasters. It is not just power supply that is affected by disasters, but also the availability and quality of firewood, as discussed in Box 2, while flooding of stoves that are stored underground affects people's ability to earn an income. In order to reduce the negative effects of reduced and uncertain energy supply, several challenges must be overcome. These include a lack of financial resources and a focus on coping mechanisms rather than adaptation. Finally, it is difficult for the residents in Nhon Ly and Nhon Hai to access more resilient energy equipment. Perhaps private companies selling this equipment miss out on the market opportunities that are there.

At present, responses to disasters have been reactive, and there is little focus on preventing or mitigating the impacts. Due to the dependence on a limited national budget and steering by central state agencies, the communes' budget can only be spent on addressing the consequences of disasters, rather than on preventing them. While it is necessary to have funds available in the event of a disaster, investments in adaptation measures are essential to protect people's lives, homes and livelihoods and will also reduce economic losses (EEA 2007; World Bank 2010a; 2010b). Households, however, do not have access to the necessary assets and finance for adaptation measures. Additional efforts to raise awareness (for example initiated by NGOs or mass organisations) amongst officials and local people of the importance of adaptation to climate change will be critical, and should involve a greater focus on energy resilience. These campaigns could involve demonstrating the feasibility and benefits of small-scale renewable energy technologies, as well as appliances that will improve energy resilience. While local authorities will be essential in the delivery of these campaigns, this should also be done in collaboration with organisations such as the Red Cross and the Women's Union since such organisations have experience of working with local people on community projects. Finally, cooperation with other stakeholders, most notably EVN should be strengthened, to collaboratively address problems in the energy supply. Table 6 provides a summary of recommended actions to be taken by key stakeholders.

Table 6. Recommendations for stakeholders

Stakeholders	Recommendations
National government	Establishment of competitive feed-in tariffs Enable competition in electricity transmission and distribution
Electricity of Vietnam (EVN)	Provide warnings prior to anticipated blackouts Train local people to deal with blackouts
City government	Enhance cooperation with EVN
Local authorities	Given enough resources, initiate local energy planning Coordinate efforts with NGOs or local mass organisations to obtain funding for energy investments
Technical departments	Using local energy planning or another approach to holistically address the energy needs of vulnerable populations, together with academia, mass organisations and NGOs Train local people to deal with blackouts Inform the people's committee on the safety standards of the electricity infrastructure
Private sector	Explore market potential for more disaster-resilient energy production technologies
CCCO	Incorporate energy in the citywide climate change resilience strategies
Academia/researchers	Technical assessment of energy solutions for Quy Nhon Research on appropriate funding mechanisms
Mass organisations and NGOs	Awareness-raising campaigns for local authorities and households on the need for adaptation measures, focusing on energy
Households	Invest money (when available) in adaption measures rather than in coping measures

On a broader scale, adaptation may involve the development of decentralised energy systems that make use of renewable energy sources such as wind, biomass and solar energy. Small-scale renewable energy technologies, including biogas, improved cookstoves, solar lanterns and micro-wind turbines, could all be considered for Nhon Ly and Nhon Hai. Most of these measures not only provide benefits in case of disasters but also alleviate poverty, reduce GHG emissions and offer public health benefits. However, more specific information will be required on both current and future energy demand, as well as how demand varies according to the time of day and season. In addition to the requirement for information on energy needs, other resources will need to be taken into account, including access to financial, human and social capital. Local energy planning offers a promising approach to assessing the energy needs and potential resources of a community. In such an approach, experts and local people jointly conduct data collection, select energy alternatives and develop implementation plans. By looking at the commune holistically, the optimal scale for energy systems and appropriate technologies can be selected. Such an approach could be initiated by the commune authority.

Further research will be required to ascertain which renewable energy technologies will be suitable for the specific context in Quy Nhon, and how they might be financed to ensure that those most vulnerable to climate-related energy impacts can access these technologies. For example, small hydropower systems are unlikely to be suitable, while solar panels may be at risk from storm damage. Micro-wind appears to hold considerable potential for Quy Nhon, as do biogas systems for which the waste produce of activities such as seafood processing could be used as inputs, with co-benefits in terms of waste management. Furthermore, the risk of flooding and coastal erosion means the location of vital infrastructure must be carefully considered.

In addition to the technical solutions described above, there are a number of operational measures to be implemented at the city scale; for instance, providing communities with prior warning of planned power system blackouts. The city authorities (people's committees) will need to work more closely with electricity companies to ensure that they undertake surveys of power failures, electricity infrastructure that cannot meet safety standards, and to invest in upgrades. In addition, city authorities need to ensure that, whenever possible, electricity companies inform people in advance of power cuts, so that local people and businesses can prepare for them. Open dialogues between electricity companies, people's committees, representative target groups and technical agencies should be promoted; these dialogues would promote a greater and shared understanding of the impacts of electricity shortages and disaster events, and could be used to advance solutions that benefit all stakeholders. Another recommendation would be to train local people to fix energy systems in the event of a disaster. Training could be done by EVN, as this also directly reduces their need for repairmen. Although structural measures such as the World Bank-funded project in Bicol in the Philippines (see Section 2.2) have attempted to address the impacts of storms on power grids, they will not solve other climate-related disaster factors, such as blackouts that occur on summer days. These initiatives are also focused on large-scale energy systems and do little to address the impacts on the poor, such as the availability of fuelwood and flooding of stoves. Initiatives that aim to address the disaster resilience of energy systems should focus on the multiple scales of energy systems from the national to the local level.

The specific socio-economic and environmental context in Quy Nhon will need to be taken into account in developing a more resilient energy system that is adapted to the future challenges that climate change is likely to pose (Sovacool and Drupady 2012). A critical component of a future energy system will be the participation of a wide range of stakeholders, which must include local people (Hossain Mondal *et al.* 2010; Gippner *et al.* 2013). However, energy is not yet considered a key concern in the city's resilience strategy. This should be a task for the city's Climate Change Coordination Office (CCCO), although the participation of various stakeholders, including local authorities from the city to commune level, NGOs and mass organisations, electricity companies, the DOIT and academia, will be essential. Technical departments in particular should work closely with academic researchers, mass organisations and NGOs to conduct further research on the renewable technologies that are relevant for local off-shore fishermen and seafood-processing groups in coastal areas.

Technical departments should also inform people's committees on the safety standards of the electricity infrastructure, so that the people's committees can convince the electricity company to make further investments. This is critically important in the context of increasing disasters such as typhoons and storms in Quy Nhon. It is, however, problematic that new policies, such as Vietnam's Green Growth Strategy, are designed and implemented in a top-down fashion and are unlikely to consider the specific needs of local communities and contexts. More bottom-up approaches, such as local energy planning, would be likely to yield more appropriate results and could potentially address issues inherent in a centralised power-generation system, such as inflexibility. Such an approach could be initiated by the ward/commune authorities and run with technical supervision from the provincial or city departments of industry and trade.

However, the current policy situation in Vietnam makes energy systems that go beyond the household level difficult. Negotiations would have to be held with EVN to address the distribution of electricity. Further, as discussed in Section 2.5, more appropriate pricing of surplus electricity generated from renewable energy sources will be necessary. In the long term, competition should be introduced to the energy market; however, a shorter-term solution would be if the Ministry of Industry and Trade would guarantee competitive feed-in tariffs, as these would give developers more certainty as to whether they can repay their loans and recoup their investments. Thailand and the Philippines provide examples that Vietnam may seek to follow. Although there are other incentives for renewable energy production in addition to the feed-in tariffs, such as loans at preferential rates, in practice accessing these loans can be challenging (Nguyen *et al.* 2012a). In this case, an important role for local authorities from the city to the commune level will be to find financial resources to support local people. To do this, they can work with local mass organisations such as the Women's Union, the Red Cross and other NGOs (both local and international) since these organisations often have access to other funding channels.

Although there are already some existing financing mechanisms available for small-scale renewable energy technologies, these unfortunately have little relevance to people in Nhon Ly and Nhon Hai. For example, there are a number of subsidy schemes for biogas, but these focus on farmers rather than fishermen. Since many of the people in Nhon Ly and Nhon Hai are seafood producers and fishermen they are not eligible for these schemes even though they may have sufficient waste to run biogas systems. Solar water heating systems, for which there is also a subsidy scheme, remain expensive even with

a subsidy and are therefore out of reach for most poor people. Moreover, it is questionable whether a solar water heating system is able to address people's energy needs: the groups investigated here might be better served by solutions that address other needs, such as cooking or lighting, and these needs should be prioritised by the residents themselves. Many of the households have low incomes and are unlikely to have the up-front funds necessary to invest in technologies and appliances, even if they may save them money in the longer term. Even small investments, i.e. VN$ 210,000 (US$ 10) for an improved cookstove or solar lantern can be unaffordable for these households.

Although the microfinance sector is well-established in Vietnam (Nguyen and Vogel 2011), special credit schemes for energy have not yet been set up. It seems therefore that low-income households will require donor support or dedicated funding schemes in order to meet their energy needs. Support packages, regardless of who initiates them, should thus be targeted at the poorest households, and in particular at women-headed households. For microgrids, finance is also an issue but here initial investments can be recouped through user fees.

To conclude, there are several barriers to the development of a resilient energy system for the inhabitants of Nhon Ly and Nhon Hai. At the local level, barriers include a lack of attention paid to adaptation measures. This issue seems to be relevant for all groups in the communities, from the local authorities to mass organisations and households. And while there are funds available to help people to cope with the impacts of a disaster, measures that encourage adaption to climate change would enable local communities to become more resilient to climate disasters. Awareness raising and strengthened cooperation between different stakeholders (such as commune and city people's committees and the EVN) would probably improve this situation. At the national level, it will be necessary to amend the energy market structure in order to ensure the successful implementation of renewable energy technologies at the local level. This has to be supported by financing mechanisms, such as microcredit or donor funding, which will need to be targeted at the poorest members of society. Finally, it is essential that any measures take into account local energy contexts, including energy demand and potential, as well as the needs and perspectives of a wide range of stakeholders. Ensuring that energy systems are resilient to climatic changes will be essential to ensure that supplies are continual and affordable especially for vulnerable people.

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Appendix 1. Map of Binh Dinh Province and Quy Nhon City in Vietnam

Appendix 2. Questionnaire form

QUESTIONNAIRE

Village:

Ward:

No:

Interviewer

Date

Thank you for agreeing to participate in this study. This research project is investigating energy resilience to disasters in Quy Nhon City. The project objectives are 1) to understand the impacts of natural disasters on energy use amongst vulnerable groups in Quy Nhon City; 2) to identify suitable alternative energy solutions for vulnerable groups for disaster-preparedness planning. The questionnaire aims at collecting vulnerable groups' opinions in Quy Nhon City's wards about the effects of disasters on energy supplies and current energy demand as well as access to resources. I anticipate that this survey will take about 30–40 minutes to complete. I would like to reassure you that any information you provide will be treated as confidential. Participation in this research is anonymous and you will not be identifiable by name in any outputs from this study. If for any reason you want to withdraw from this study, you may do so at any time. Finally, if you have any questions or comments on this study, please do not hesitate to ask. Thank you for your cooperation in advance.

If you have any questions, please contact with Ms Hoang Thanh Binh, Green Innovation and Development Centre via Email: binh@greenidvietnam.org.vn or Phone: 0908 600 287

Section A. General information

1 Full name:

2 Gender: ☐ Male ☐ Female

3 Age:

4 Number of household members:

How many people living in your household are of working age (18–55)?

5 What is your main current occupation?

- ☐ Agriculture
- ☐ Construction
- ☐ Fishery-related labourers
- ☐ Processing/selling fish
- ☐ Street vendor
- ☐ Other (please specify)

6 Main source of income for the household:

Average monthly individual income

- ☐ Less than VN$ 500.000 (US$ 25)
- ☐ VN$ 500.000 to VN$ 1 million (US$ 25–50)
- ☐ VN$ 1–2 million (US$ 50–$100)
- ☐ VN$ 2–5 million (US$ 100–$250)
- ☐ More than VN$ 5 million (US$ 250)
- ☐ No answer

Section B: Energy consumption

I Electricity

7 Does your family have access to the national grid? ☐ Yes ☐ No

8 On average, how much do you pay for the electricity every month?

II Lighting

9 What types of lighting appliances have your family been using? How many per type? On average, how many hours per day do you usually need lighting?

☐ Incandescent light bulbs:	Number of bulb(s)	Hours/day:
☐ Fluorescent lights:	Number of light(s)	Hours/day:
☐ Compact lights:	Number of light(s)	Hours/day:
☐ Solar lanterns:	Number of lantern(s)	Hours/day:
☐ Other:		

III Cooking

10 What kinds of stoves/ovens does your household use for cooking?

☐ Electric stove/oven	☐ Traditional coal stove	☐ Wood stove
☐ Gas stove/oven	☐ Improved coal stove	☐ 3-stone/open fire
☐ Rice husk stove	☐ Other ……..	

11 What types of traditional fuel does your household use for cooking?

	Available quantity	**Purchased quantity**	**Average price per kg in VN$**
☐ Firewood	.....kg/month	.....kg/month	
☐ Charcoal	.....kg/month	.....kg/month	
☐ Rice husks	.....kg/day	.....kg/day	
☐ Corn cops	.....kg/day	.....kg/day	
☐ Other (cassava stalks, leaves, straw, sawdust etc.)	.....kg/day	.....kg/day	

12 If your family uses a gas stove/oven, how much gas do you use?

Your family uses about ……..tanks of gas per year. One tank contains …….. kg of gas

If you use gas for cooking, is gas available in your community? ☐ Yes ☐ No

13 Does your family use biogas for cooking? ☐ Yes ☐ No

If yes, how many hours does your family use it for: .....hours/day.....day/month.....month/year

IV Transportation

14 What type of vehicle does your household use for transportation? And how many of each?

☐ Bicycle(s) ☐ Motorcycle(s) ☐ Car(s)

☐ Electrical bicycle(s) ☐ Boat(s) ☐ Other

15 Does your family have an electrical bicycle? How much capacity does the battery have? (Ampere-hours). How often do you charge the battery? (time/month)

16 If your household has motorcycle(s), how much is being spent on gasoline for them? In total your family spends approximately …… litres/month on gasoline.

17 Does your family have a car? How much is being spent on gasoline or diesel for them**?** In total your family spends approximately …… litres/month on gasoline/diesel.

18 Does your family have a boat? How much is being spent on diesel for them? ……
In total your family spends approximately ……litres/month on diesel.

V Agriculture and aquaculture

19 Does your household have any of the following machines for agriculture and aquaculture, or for other business uses (such as seafood processing or storing fish)? ☐ Yes ☐ No

If yes, please specify how much you use them

Diesel-powered machines	**Quantity**	**Diesel consumption**	
		Litres/month	**Month/year**
Tractor(s)/plow(s)			
Agri. water pump(s)			
Diesel grain mill(s)			
Other			
Other			

Electric machines	**Quantity**	**How much do you use them?**		
		Hours/Day	**Days/Month**	**Month/Year**
Agri. water pump(s) (1HP = 746 watt)				
Milking machine				
Electric grain mill(s)				
Other				
Other				
Other				

VI Household energy use

20 Does your household have any of the following appliances?

Appliance	**Quantity**
☐ Electric water heater	
☐ Television/radio/ CD/DVD/VDO player	
☐ Electric fan	
☐ Electric iron	
☐ Charcoal iron	
☐ Mobile phone	
☐ Refrigerator/freezer	
☐ Air-conditioning	
☐ Sewing machine	
☐ Washing machine	
☐ Computer	
☐ Vacuum cleaner	
☐ Domestic electric water pump	
☐ Other	

Section C. Current household energy production

21 Does your household use diesel/gasoline generators? ☐ Yes ☐ No

If yes, what is the approximate amount of gasoline/diesel used for the generators in total (litres/month):

On average, how much do you spend on gasoline per month?

22 Does your household use a solar water heater? ☐ Yes ☐ No

If yes, please describe their capacity and system area:

Capacity (litres):

System area ($m^{2)}$

23 Does your family use solar panels? ☐ Yes ☐ No

Capacity (Wp):

Number of panels:

24 Does your family use a wind turbine? ☐ Yes ☐ No

If yes, please describe its capacity:

25 Does your family use pico-hydropower? ☐ Yes ☐ No

If yes, please describe its capacity:

26 Does your house use a biogas digester? ☐ Yes ☐ No

If yes, what are they used for?

Please describe their type and capacity:

No.	Capacity	Type
1.	m^3	Dome/Plastic/Other
2.	m^3	Dome/Plastic/Other

Section D. Potential resources

27 If you keep any of the following animals, how many of each do you have?

- ☐ Pigs
- ☐ Cattle
- ☐ Poultry
- ☐ Goats
- ☐ Rabbits
- ☐ Aquaculture
- ☐ Other

28 If your family grows crops, what do you grow?

Crop	Areas (VN unit: sào*)	Productivity (kg/sào/year)
Rice		
Maize		
Beans		
Peanuts		
Potatoes		
Flowers and bonsai		
Other		

* sào is equivalent to 360m^2

Section E. Climate change

29 What do you know about climate change?

- ☐ Temperature increases
- ☐ Increase of natural disaster intensity and frequency (floods, storms, heat waves etc.)
- ☐ It is caused by increasing greenhouse gas emissions
- ☐ Sea-level rises
- ☐ Other (please specify)
- ☐ Don't know

30 How do you know that?

- ☐ Media (TV, radio, newspapers)
- ☐ Mass organisations
- ☐ Government staff
- ☐ Friends/relatives
- ☐ Other (please specify)

31 Is your village/ward prone to natural disasters? ☐ Yes ☐ No ☐ Not sure

32 What type of disaster is your village/ward most exposed to?

☐ Typhoons ☐ Cyclones ☐ Tidal surges ☐ Flash floods ☐ Floods

☐ Erosion ☐ Saline intrusion ☐ Drought ☐ Landslides ☐ Heat waves

33 How frequent are these disasters compared to 10 years ago?

Type of disaster	Increased	Stable	Reduced
Typhoon	☐	☐	☐
Cyclone	☐	☐	☐
Tidal surge	☐	☐	☐
Flash flood	☐	☐	☐
Flood	☐	☐	☐
Erosion	☐	☐	☐
Saline intrusion	☐	☐	☐
Drought	☐	☐	☐
Landslide	☐	☐	☐
Heatwaves/long periods of very high temperatures	☐	☐	☐

34 How intense are these disasters compared to 10 years ago?

Type of disaster	Increased	Stable	Reduced
Typhoon	☐	☐	☐
Cyclone	☐	☐	☐
Tidal surge	☐	☐	☐
Flash flood	☐	☐	☐
Flood	☐	☐	☐
Erosion	☐	☐	☐
Saline intrusion	☐	☐	☐
Drought	☐	☐	☐
Landslide	☐	☐	☐
Heatwaves/long periods of very high temperatures	☐	☐	☐

35 **Which problems are the most serious for your household in times of disaster?**

	Typhoon	Cyclone	Flood	Tidal surge	Flash flood	Saline intrusion	Drought	Land slide	Erosion	Heat wave
People's safety										
Insufficient food										
Insufficient drinking water										
Damage to house										
Lack of work										
Have to borrow money at high rate										
Human disease										
Lack of energy supply/power cuts										
Evacuation										
Waste disposal										
Other										

Section F. Impacts of disasters on energy supply

36 Do you have any problems in energy access? ☐ Yes ☐ No

37 What impacts of energy supply problems have you been facing?

☐ Disruption of current business, jobs

☐ Increased labour cost

☐ Interruptions during cooking/caring/other activities for family members

☐ Unable to generate income

☐ Increased expenditure on alternative fuels during blackouts

☐ Other (please specify)

38 When do you have most difficulty in accessing energy for your own activities?

☐ Before disasters ☐ During disasters ☐ After disasters

39 Regarding blackouts, how long do they last for?

Before disasters (hours/day):

During disasters (hours/day):

After disasters (hours/day):

Were you informed in advance? ☐ Yes ☐ No

40 What are the most important energy uses you need in times of disasters?

- ☐ Cooking (electric/gas stoves etc.)
- ☐ Lighting (light bulbs etc.)
- ☐ Transportation (boats, cars etc.)
- ☐ Cooling (air conditioners, electric fans, refrigerator/freezer etc.)
- ☐ Heating (electric water heaters etc.)
- ☐ Drying
- ☐ Entertaining (TV, radio, CD/DVD players etc.)
- ☐ Communicating (mobile phones etc.)
- ☐ Other (please specify)

41 Do you have any back-up measures for dealing with energy disruption during and after disasters? Please describe those measures:

42 Do you receive any help during periods of energy disruption?

- ☐ Government
- ☐ Neighbours/ friends/ family members
- ☐ Employers
- ☐ Mass organisations (e.g. Women's Union, Red Cross, etc.)
- ☐ Electricity company
- ☐ Other (please specify)

How did they help you in that situation?

43 If you are a fisherman, were your communications impaired by power blackouts?

☐ Yes ☐ No

If yes, please describe how:

Section G. Policies

44 Have you heard of the national strategy for climate change or green growth strategy?

If YES, please describe HOW and WHEN you hear about it:

If NO, would you be interested in finding out more about the strategy?

And please describe what BENEFITS you expect to gain from such policies:

45 Are you aware that the city of Quy Nhon has a disaster preparedness and mitigation plan?

If YES, from which source did you hear about this?

- ☐ Commune PC
- ☐ Village Rescue Team
- ☐ Village/ward head
- ☐ Media (TV, radio, newspaper etc.)
- ☐ Village/ward loudspeaker
- ☐ Other (please specify)

If NO, would you be interested in finding out more about the plan?

Please briefly describe WHAT you can contribute to this plan:

46 Have you ever participated in any training or community activity related to disaster impact mitigation?

☐ Yes ☐ No

If **YES**, which activities do you participate in?

- ☐ Community-based disaster management trainings
- ☐ First aid training
- ☐ Infectious disease control training
- ☐ Other (please specify)
- ☐ Fire control drill
- ☐ Evacuation drill
- ☐ Sanitation trainings

How do you evaluate these activities?

☐ Very efficient	☐ Efficient	☐ Neutral	☐ Poor

If you have any other comments or questions, please write down here:

THANK RESPONDENT FOR THEIR PARTICIPATION.

Appendix 3. List of interviewees

No	Name of interviewee	Organisation
1	Nguyen Van Thang	Department of Industry and Trade in Quy Nhon City
2	Dinh Thi Minh Ha	Department of Industry and Trade in Quy Nhon City
3	Oanh	Women's Union in Quy Nhon City
4	Phan Tuan	Department of Economics, People's Committee in Binh Dinh Province
5	Nguyen Tien Trinh	Committee for Flood and Storm Control in Binh Dinh Province
6	Tran HuuKinh	Committee for Flood and Storm Control in Quy Nhon City
7	Nguyen Xuan Phu	Committee for Flood and Storm Control in Quy Nhon City
8	PhanKe Hung	Committee for Flood and Storm Control in Quy Nhon City
9	Tran Dinh Chinh	Chairman of Quy Nhon City's Red Cross
10	Nguyen Thanh Danh	Vice chairman of Nhon Ly People's Committee
11	Pham Van Hung	Chairman of Nhon Hai People's Committee
12	Nguyen Van Nhung	CCCO in Quy Nhon city
13	Dinh van Tien	CCCO in Quy Nhon city
14	Nguyen Can	Owner of off-shore fishing boat

Appendix 4. Sample interview protocol

I. Climate change

1. The participation level and role of organisations?
2. The situation of disasters and climate change in Quy Nhon city?
3. Impacts of climate change on poor people? Effects of climate change on men and women in Quy Nhon City? What is the difference? Why?
4. What are the major activities in preventing disaster planning in Quy Nhon? Which levels do local people become involved in?
5. Is there any priority for the development and implementation of plans for preventing natural disasters or an action plan for preparing for climate change in Quy Nhon? If yes, what is the priority for this plan? If no, in your opinion, how can this policy be mainstreamed and implemented?
6. What about the development and implementation of plans for preventing natural disasters, and processes for preparing for climate change action plans in Quy Nhon? How did the relevant departments and affected groups join? Advantages and disadvantages?

II. Effects of climate change on energy supply and sustainable energy models

7. When did power cuts occur, in which circumstances? How do power cuts impact on people's lives and women's lives in particular? Which are the alternative solutions in the case of power cuts? Are there any agencies (EVN or relevant authorities) who can provide support in such cases?
8. In your view, as natural disasters increase in both frequency and intensity, how should this influence decisions regarding local power supply systems?
9. In your view, what are the best types of local energy system? What is the application of these energy types? Why? What are the advantages and disadvantages? Is the energy demand from men or women?
10. Should a sustainable energy model include poor fishermen, small businesses and poor people in planning for more frequent disasters? Do you think that this would be a useful solution to contribute to implementing the national strategy for green growth «Reducing the intensity of greenhouse gas emissions and promoting the use of clean and renewable energy »?
11. In your view, what is the local potential when applying sustainable energy? Difficulties and solutions?
12. In your view, what kind of sustainable energy is suitable for the groups including offshore fishermen's groups, seafood processing groups and poor women's groups in Quy Nhon? (eg. solar power, wind power, biogas, biomass).
13. What is the difference between men's and women's energy needs? Are there any initiatives on alternative energy modes?

14. Are there any proposals to support creating favourable conditions for these groups, including offshore fishermen's groups, seafood-processing groups and poor women's groups when applying a sustainable energy model? (all relevant policies and local solutions)
15. Did you know of any sustainable energy measures/initiatives for households, fishermen, and the small-scale processors which are applicable to natural disasters and extreme events such as heat waves? Difficulties?

III. Energy policies

16. What is your organisation's responsibility for encouraging these groups to use sustainable energy models?
17. According Decision No. 2139/QD-TTg approving the National Strategy on Climate Change dated 5th December 5 2011, what is the actual situation regarding implementing climate change adaptation and GHG mitigation measures? What is the involvement of the relevant departments and affected people?
18. What is your opinion on Decision No. 1393/QD-TTg approved the National Green Growth Strategy dated 25th September 2012? It is feasible? Difficulties and challenges?
19. What current programmes and projects related to sustainable energy are being deployed to implement the National Strategy on Green Growth in your area? Difficulties and advantages? Have you received any support from local agencies, competent agencies and local people in the process of encouraging the application of the sustainable energy model?

Appendix 5. Energy models/ appliances used in the simulation game

Solar lantern

Price: 3 coins

Reduces energy costs by: 1 coin

Increases income during disasters by: 1 coin

Solar PV-panel

Price: 18 coins

Reduces energy costs by: 3 coins

Increases income during disasters by: 3 coins

Solar lantern

Price: 9 coins

Reduces energy costs by: 2 coins

Increases income during disasters by: 2 coins

Energy-saving light bulb

Price: 1 coin

Reduces energy costs by: 1 coin

Increases income during disasters by: 0 coins

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Published by IIED, 2014

IIED order no: 10710
http://pubs.iied.org/10710IIED.html

ISBN 978-1-78431-064-6

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