Thai coast project report

Work package 3: Socio-economic Impact Assessment, Coping Mechanisms and Resilience

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1. Aim

To conduct a quantitative socio-economic assessment of how people manage and respond to hydro-meteorological hazards (resilience, and coping mechanisms, of coastal communities to hydro meteorological hazards of varying magnitudes).

2. Executive Summary

Coastal provinces in Thailand face substantial threats from climate change induced hydro-meteorological hazards. Human populations and their livelihoods are at greater risk. This report presents the socio-economic characteristics and vulnerabilities of two coastal provinces in Thailand: Krabi and Nakhon Si Thammarat. In addition, the report addresses how damage caused by hydro-meteorological hazards can be minimized and how the recovery can be facilitated by socio-economic resilience. The social dimension focuses on demographic characteristics as well as available public health emergency resources within the two coastal provinces. The economic dimension then focuses on issues such as settlement types and transport links and infrastructure. Quantitatively combining the two dimensions, social and economic, we have produced socioeconomic resilience index maps for the two coastal provinces.

Measuring and mapping socio-economic resilience within the study area was based on the available data gathered from the social and economic dimensions. Indicators were applied uniformly across subdistricts. Results show that while socio-economic resilience is generally higher in the more urbanized areas, there are greater variations from one subdistrict to another. It was evident that district averages for socio-economic resilience scores often mask the variations at sub-district level. With regards to the soft and hard coping capacities, the average resilience score across districts in both provinces was 3 out of a possible 4, indicating high levels of resilience in most of the districts.

Several coping measures have been implemented in Thailand to try and increase the resilience of people residing in areas affected by hydro-meteorological hazards. Some jurisdictions have integrated climate change adaptation into provincial development plans and sector policies. For long term sustainability of coping measures, capacities of community groups and local authorities in Nakhon Si Thammarat and adjacent Phatthalung, and Trang Provinces have been strengthened through implementation of locally appropriate adaptation measures.

Some of the successful coping measures in mitigating hydro-meteorological hazards include local production of life jackets, erection of village level early warning towers and sirens, and community training programmes in warning and evacuation drills. Other strategies include protecting existing mangrove areas, rehabilitation of degraded mangrove, and the planting of Nipa palm trees to generate additional income for communities and households whilst protecting the areas from climate change related floods. Forest and watershed management has been carried out in some areas to mitigate the risks of floods with rubber plantations inter planted with different fruit tree species. Improving radio networks to connect upstream and downstream villages to mitigate the impacts of flash floods along an entire river basin has also proved very helpful.

Households may individually apply autonomous coping mechanisms including protection (e.g., stone breakwaters, sandbags, bamboo revetments, and dike heightening), retreating (which implies that all-natural system effects can occur and human impacts are minimized by pulling back from the coast e.g. construction of new water gates) and accommodation (house re-building and renovation). However, individual coping strategies without collective action to pull in one direction may not be effective solutions due to the occurrence of negative externalities if the neighbours do not apply/maintain their own protection structures. Social cohesion within an affected community is important in binding a community together and collectively developing successful coping mechanisms.

3. Introduction

Coastal areas are becoming more and more vulnerable to the impacts of climate change. Over recent decades, natural disasters including tropical storms, cyclones, and floods have become more frequent and severe, with increasing loss of life and damage to livelihoods, property, and infrastructure. The management of such disasters affecting coastal areas involves vulnerability assessment in both natural (e.g. (Gornitz, 1991; Gornitz et al., 1994) and human environments (e.g. McLaughlin et al., 2002; McLaughlin & Cooper, 2010). In a coastal vulnerability assessment conducted in Samut Sakhon coastal zone in the Gulf of Thailand, Bangkok Metropolitan Region, coastal vulnerability was highly differentiated and was found to be influenced by variations in socio-economic indicators such as land use, population density and cultural heritage, rather than physical factors (Duriyapong & Nakhapakorn, 2011). It is not clear whether there is a similar pattern in other coastal provinces of Thailand namely Krabi and Nakhon Si Thammarat. As such, this investigation sought to provide a quantitative socioeconomic assessment of the two provinces to understand their vulnerability to hydro-meteorological hazards of varying magnitudes; and to develop socioeconomic resilience index maps.

3.1 Objectives

Social dimension
1) map demography, education, and health and well-being of the population living in the study area
2) identify vulnerable groups among the affected population
3) address knowledge and information gaps that are preventing the effective application of measures to reduce risks

Economic dimension
4) Assess and map livelihoods (settlement type, cultural heritage, transport links, conservation designation, and the potential direct and indirect follow-on effects of hydro-meteorological hazards on these dimensions)

5) develop damage level maps (assessment of damage caused by disaster event e.g., buildings damaged)

6) develop risk maps, or event monitoring maps for Krabi and Nakhon Si Thammarat provinces

3.2 Outputs

Social and economic dimensions were combined to produce socio-economic resilience index maps, accompanied by a report on coping mechanisms.

3.3 Scope of the study

An earlier study conducted in Samut Sakhon, a coastal zone in the Gulf of Thailand, Bangkok Metropolitan Region, concluded that coastal vulnerability was more closely correlated with parameters to do with socio-economic characteristics in comparison with physical parameters including coastal slope and coastal erosion rate (Duriyapong

& Nakhapakorn, 2011). Building upon that study, but focusing on different coastal zones, this investigation described the socio-demographic characteristics of the population in Krabi and Nakhon Si Thammarat provinces, identifying vulnerable groups such as infants, the elderly, orphans, prisoners, and persons living with chronic ailments. The investigation also provided a description of the livelihoods within the study area. Focus was put on settlement types, cultural heritage, transport links, conservation designation, and the potential direct and indirect follow-on effects of hydro-meteorological hazards on these dimensions. Combining the social and economic dimensions, the investigation produced socio-economic resilience index maps.

4. Methodology

4.1 Study design and study area

A descriptive cross-sectional study was conducted focusing two coastal provinces in Thailand namely Krabi and Nakhon Si Thammarat (
Figure 1). Severe inundation during the rainy season influenced the selection of the two provinces for data collection so that their coping mechanisms and resilience could be strengthened. The two provinces have their specific cultural heritage worth mentioning and well-being (see Appendix A and Appendix B).
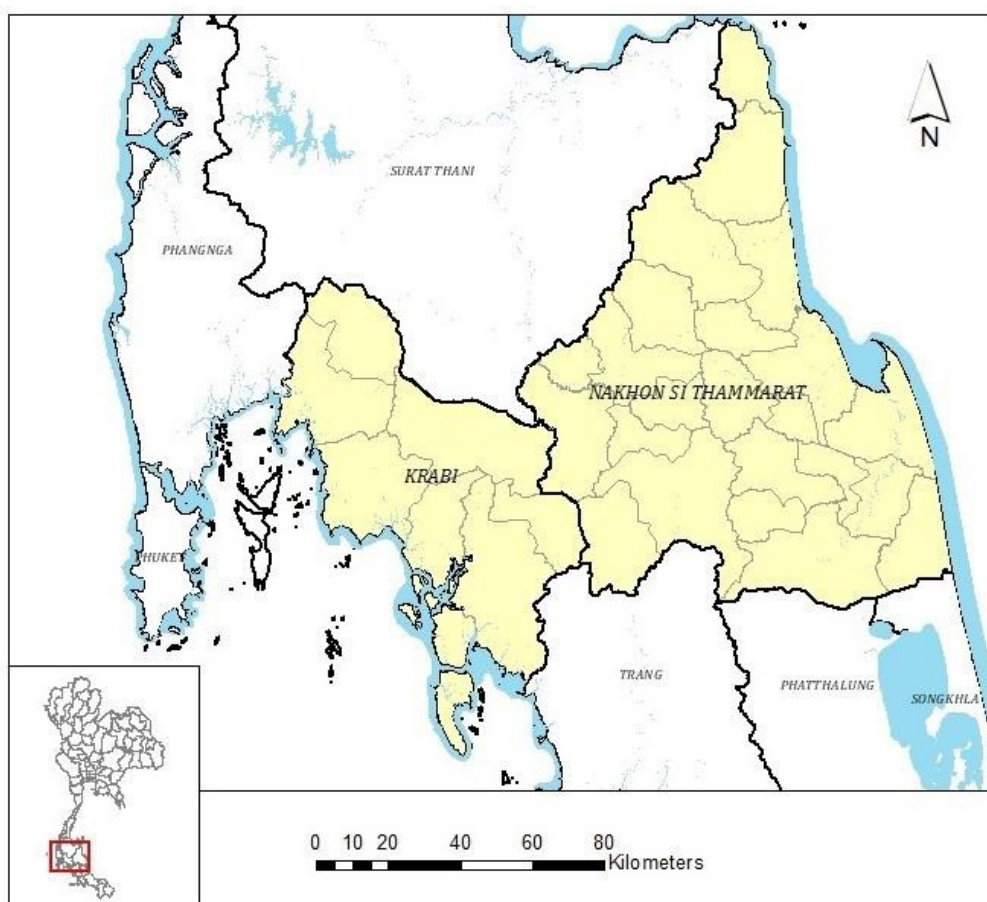
Figure 1: Map of study area, Krabi and Nakhon Si Thammarat provinces, Thailand

4.2 Population and subjects

Thailand has a sub-national administrative structure which is organised into a dual system, including local, or deconcentrated, administration and local autonomous, or decentralised, self-government. Local administration consists of provinces that are divided into districts which are then further divided into sub-districts. Local autonomous self-government consists of three types of municipalities, including city municipalities, town municipalities, and sub-district municipalities. In this study of population characteristics for the two study Provinces, we consider data across all of the administrative units of local administration and local autonomous self-government.

The study area has a total of 245 administrative units, comprising 61 and 184 units in Krabi and Nakhon Si Thammarat provinces, respectively. In both provinces, sub-districts constitute the largest portion as shown in Table 1. One major difference is the absence of a city municipality in Krabi province.

Table 1: Number of administrative units by province

Unit	Krabi[1]	Nakhon Si Thammarat[2]
District	8	23
Sub-district	48	131
Sub-district Municipality	12	49
Town Municipality	1	3
City Municipality	0	1
Total units	**61**	**184**

Source: Department of Provincial Administration, Ministry of Interior, 2017
[1] Ao Luek district = 9 sub-districts, Khao Phanom district = 6 sub-districts, Khlong Thom district = 5 sub- districts, Ko Lanta district = 5 sub-districts, Lam Thap district = 4 sub-districts, Mueang Krabi district = 7 sub-districts, Nuea Khlong district = 8 sub-districts, Plai Phraya district = 4 sub-districts, Sub-district Municipalities = 12, Town Municipality = 1
[2] Bang Khan district = 4 sub-districts, Chaloem Phra Kiat district = 3 sub-districts, Chang Klang district = 1 sub-district, Cha-uat district = 10 sub-districts, Chawang district = 8 sub-districts, Chian Yai district = 8 sub-districts, Chulabhorn district = 5 sub-districts, City Municipality = 1, Hua Sai district = 9 sub-districts, Khanom district = 1 sub-district, Lan Saka district = 4 sub-districts, Mueang Nakhon Si Thammarat district = 10 sub-districts, Na Bon district = 3 sub-districts, Nopphitam district = 3 sub-districts, Pak Phanang district = 13 sub-districts, Phipun district = 2 sub-districts, Phra Phrom district = 3 sub-districts, Phrom Khiri district = 4 sub-districts, Ron Phibun district = 5 sub-districts, Sichon district = 8 sub-districts, Sub-district Municipalities = 49, Tha Sala district = 10 sub-districts, Tham Phannara district = 3 sub-districts, Thung Song district = 8 sub-districts, Thung Yai district = 6 sub-districts, Town Municipality = 3

4.3 Secondary data collection and review of literature

The most recent secondary data on population size, age and gender distribution were retrieved from the Department of Provincial Administration in the Ministry of Interior. The 2016 in-patient data by province were retrieved from Central office for Healthcare Information (CHI) and National Health Security Office (NHSO). Statistics on the population of prisoners in Thailand as of 1 March 2018 were retrieved from the Department of Corrections under the Ministry of Justice. Data for 2018 on infrastructure and public utilities were retrieved from the Local Administrative Organization (LAO) Central Data System, Department of Local Administration, under Ministry of Interior.

4.4 Data analysis

We conducted a quantitative study in which data were gathered from various databases to assess communities' ability to cope with disasters by making use of GIS to display the findings. Simple descriptive analyses were conducted, focusing on the distribution of different variables related to the socio-demographic and economic aspects within the two coastal provinces. Inclusion of these variables was based on an earlier study which suggested that coastal vulnerability was more influenced by parameters related to socio-economic characteristics compared to physical parameters (Duriyapong & Nakhapakorn, 2011). Results of the analyses are presented as tables and charts. The analyses served to identify gaps and limitations of the information available and potential need for adaptation strategies to be effected within the coastal areas.

5. Results

Results are presented in three parts: social dimension, economic dimension, and socio-economic assessment.

5.1 Social dimension

This section describes the social dimension of coastal vulnerability in the context of Krabi and Nakhon Si Thammarat provinces. The social dimension parameters include demography, education, health status and wellbeing, vulnerable groups, public health resources, public health emergency resources as well as knowledge and information gaps.

5.1.1 Demography

In Krabi province, the proportion of children under the age of 5 ranged from 6-8%. As shown in
Figure 2, the greatest difference is among the population aged 50-64 in which the proportions range from 13% in Ko Lanta and 17% in the town municipality.
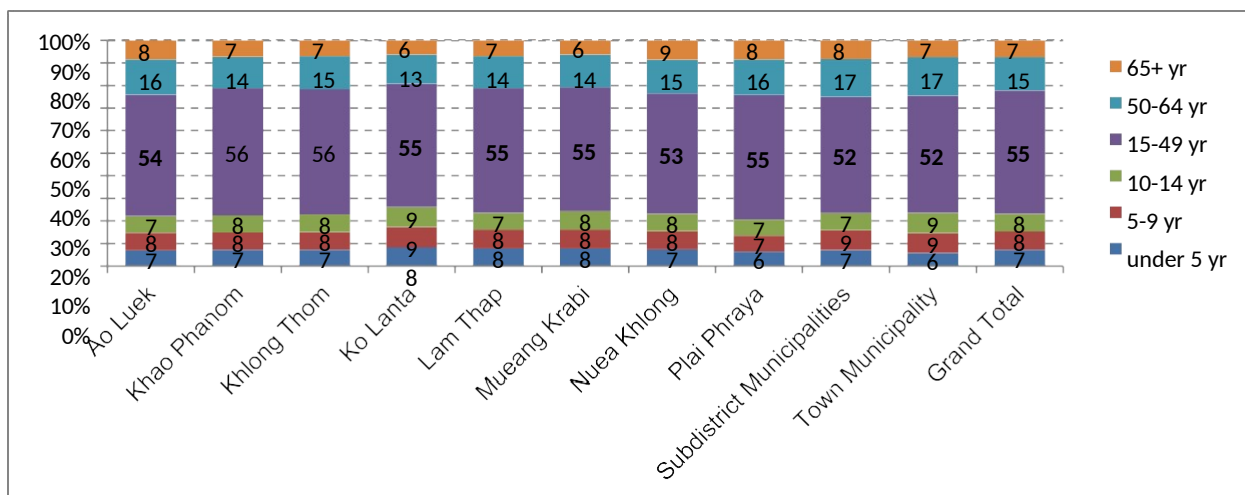
Figure 2: Distribution of population by age groups in Krabi province
Source: Department of Provincial Administration, Ministry of Interior, 2017

Figure 3 shows the distribution of population in Nakhon Si Thammarat province by age group and by administrative unit. Consistent with the observation made in Krabi province, the greatest difference in population distribution is among the 50-64 year age group where the proportions range from 14% in Bang Khan and 20% in the town municipality.
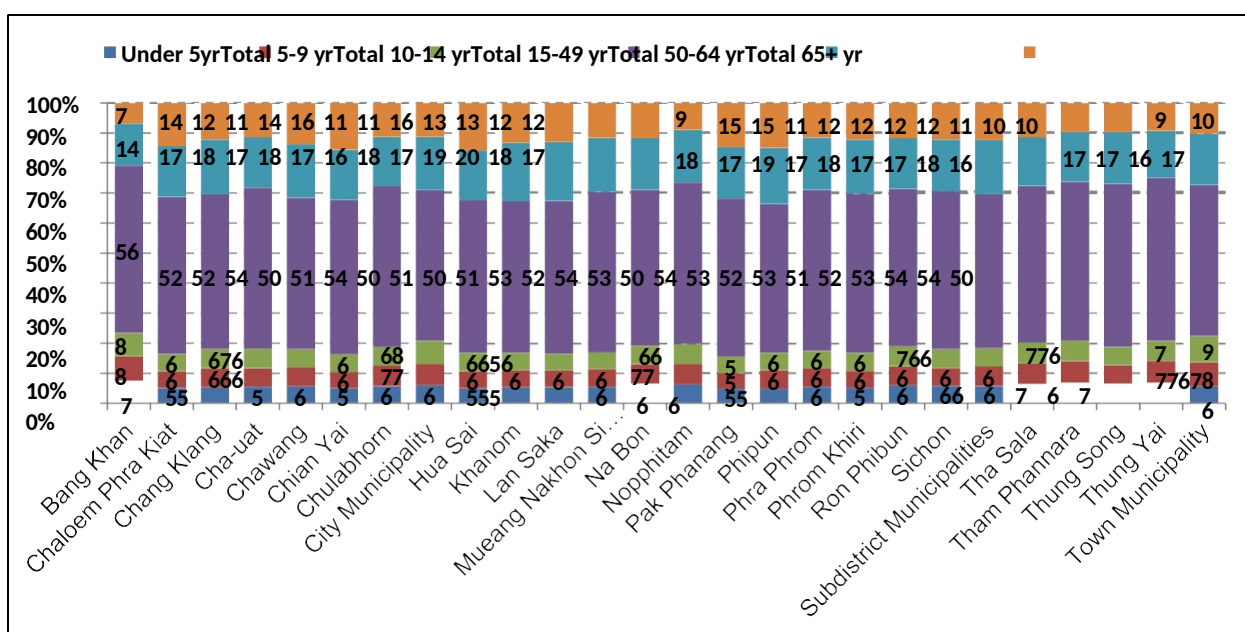
Figure 3: Distribution of population by age groups in Nakhon Si Thammarat province
Source: Department of Provincial Administration, Ministry of Interior, 2017

Distribution of non-Thai nationals

Krabi province has a total of 872 non-Thai nationals. Out of these, Mueang Krabi district has the highest number (488) constituting 56% of the total. As shown in Figure 4, all administrative units have more male non-Thai nationals than females, except for Khlong Thom district.
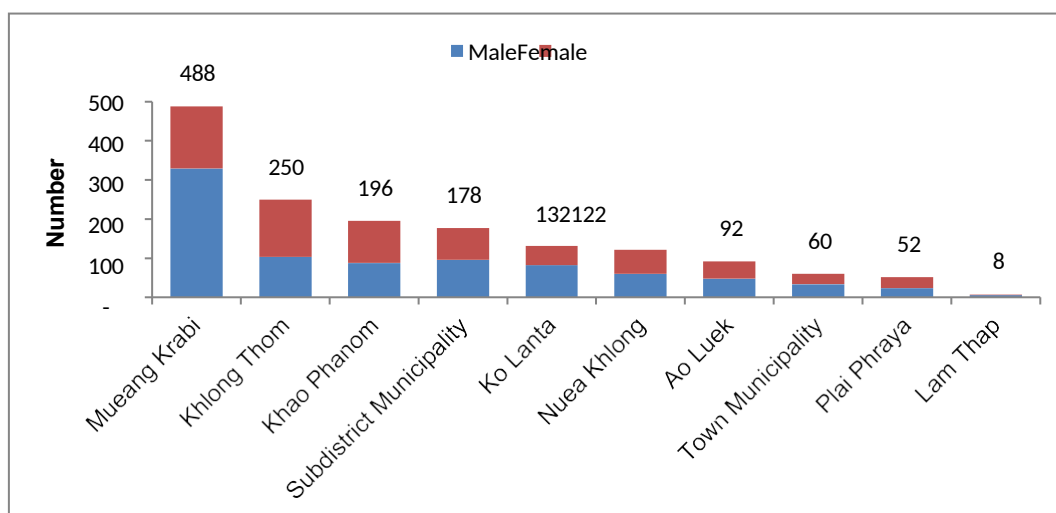
Figure 4: Distribution of non-Thai nationals by gender in Krabi province
Source: Department of Provincial Administration, Ministry of Interior, 2017

Figure 5 summarizes the distribution on non-Thai nationals in Nakhon Si Thammarat province. The province has a total of 2,685 non-Thai nationals. Out of these, Thung Song district and the sub-district municipalities combined constitute 51% of the total. There are more male non-Thai nationals than females in all administrative units in Nakhon Si Thammarat province.

Figure 5: Distribution of non-Thai nationals by gender
in Nakhon Si Thammarat province
Source: Department of Provincial Administration, Ministry of Interior, 2017

5.1.2 Education
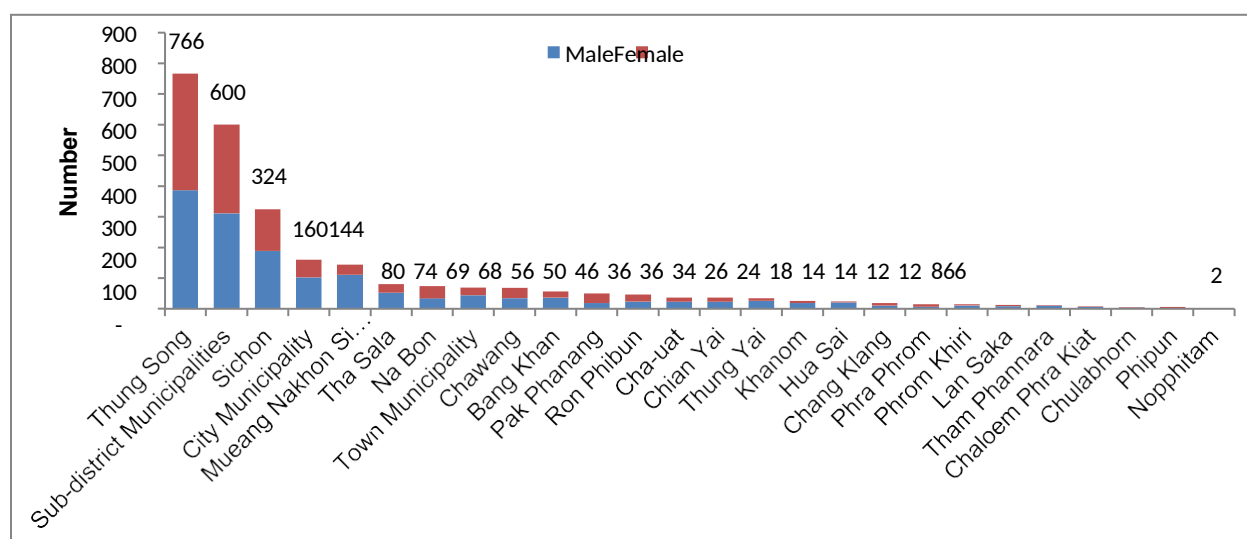
5.1.2.1 Students

a) Formal education

The total number of schools providing formal education in Krabi and Nakhon Si Thammarat provinces is 227 and 747, respectively. As shown in Table 2, female students outnumber their male counterparts in both provinces. In total, there are 217,698 students in the two provinces, comprising 107,771 (49.5%) males and 109,927 (50.5% females).

Table 2: Number of schools and total number of students enrolled in formal education

	Number of schools	Male students	Female students	Total students
Krabi	227	28942 (49.6%)	29353 (50.4%)	58295
Nakhon Si Thammarat	747	78829 (49.5%)	80574 (50.5%)	159403
Total	974	107771 (49.5%)	109927 (50.5%)	217698

Source: Office of the Basic Education Commission (OBEC), Academic Year 2018

Students enrolled in formal education in Krabi province

For Krabi province, data on the number of children enrolled in formal education was available from pre-school up to Grade 12. As shown in Figure 6, male students outnumber female students from kindergarten 3 up to Grade 6, after that, a higher proportion of female students enrolled in formal education is observed up to Grade 12.

Figure 6: Distribution of students by gender and level of education, Krabi province
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018
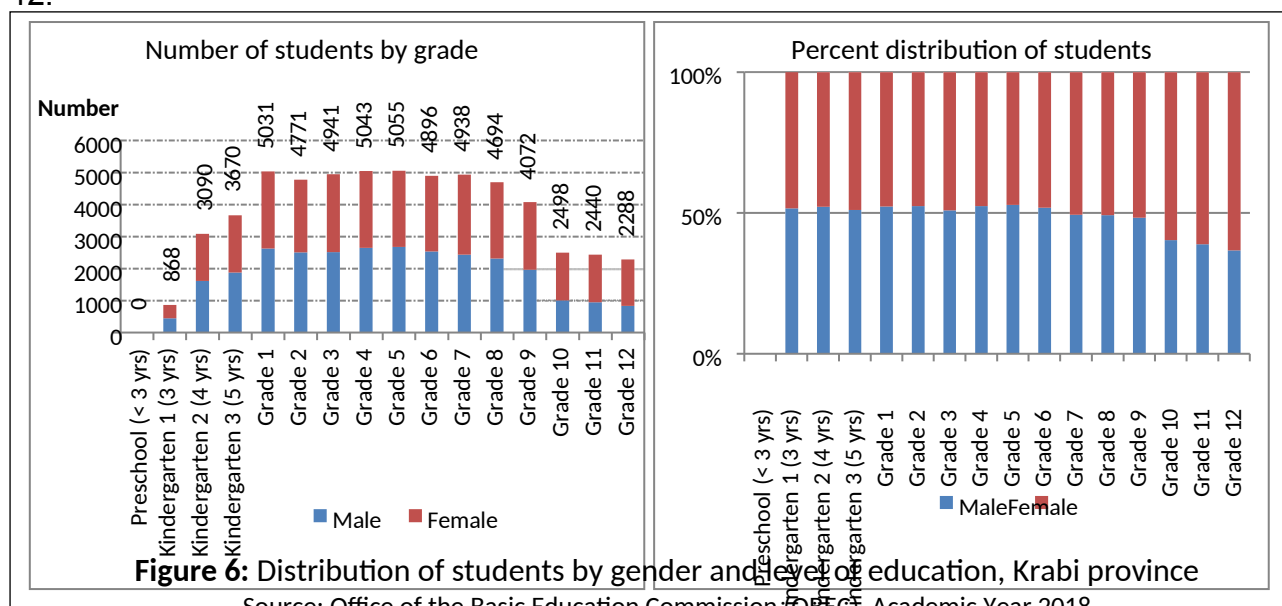
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018

Students enrolled in formal education in Nakhon Si Thammarat province

Similarly, in Nakhon Si Thammarat province, male students outnumber female students only from kindergarten 3 up to Grade 6, after that, a higher proportion of female students enrolled in formal education is observed up to Grade 12 (Figure 7).
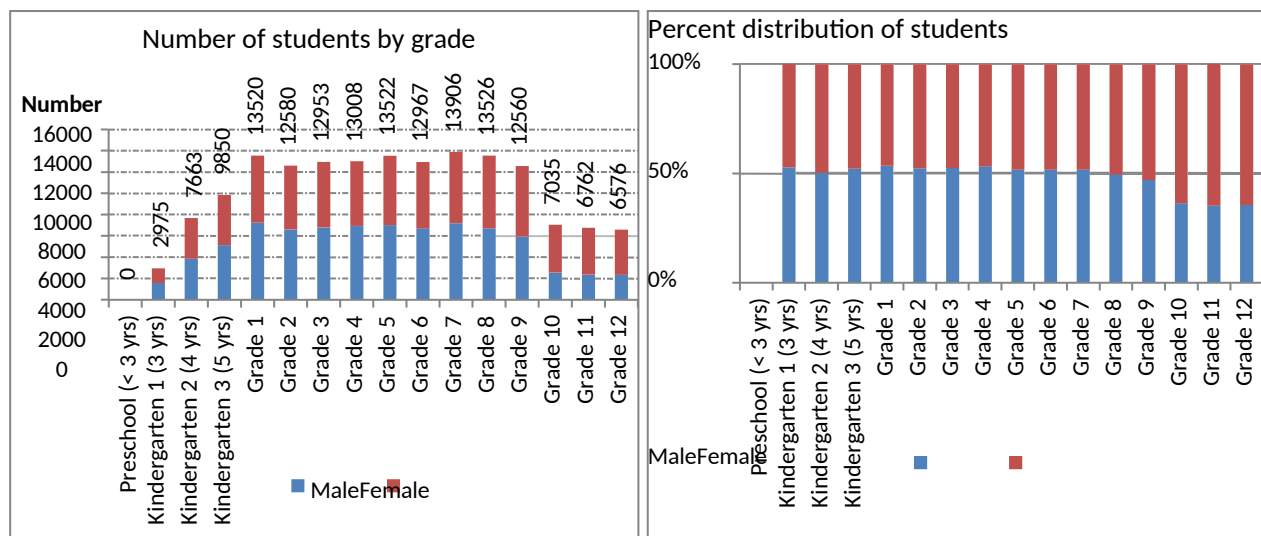
Figure 7: Distribution of students by gender and level of education,
Nakhon Si Thammarat province
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018

Schools providing formal education, and number of students enrolled

Figure 8 and
Figure 9 show the number of schools and number of students enrolled into formal education in Nakhon Si Thammarat and Krabi provinces, respectively. Only nine schools in Nakhon Si Thammarat have an enrolment population greater than 2000 students. The majority of schools (343) have student enrolments between 100 and 499, and they have a combined total of 74,159 students.
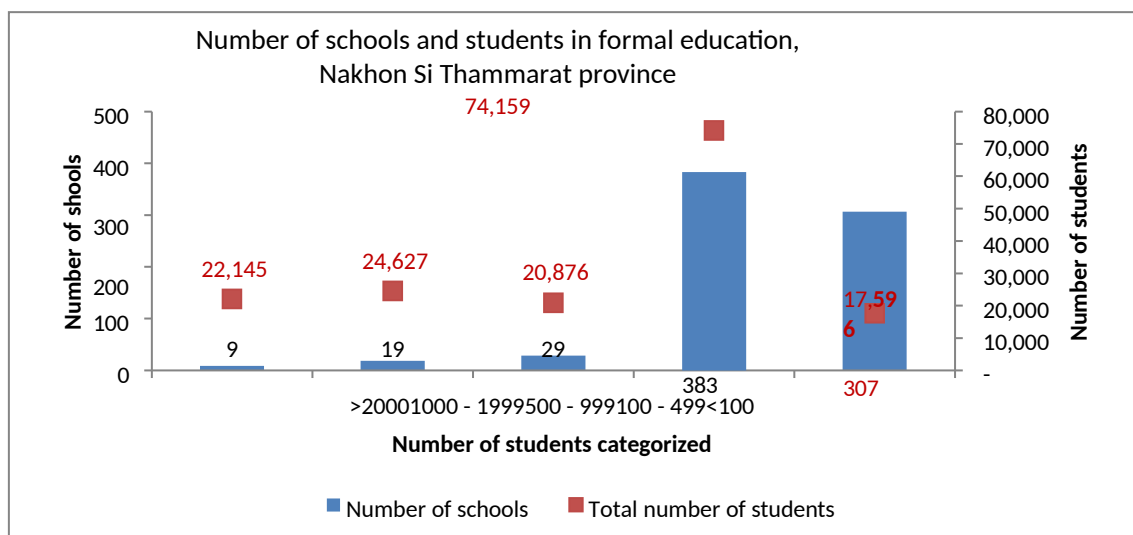
Figure 8: Number of schools and students in formal education,
Nakhon Si Thammarat province
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018

In Krabi province, only 2 schools have an enrolment population greater than 2000 students. Majority of schools (128) have student enrolments between 100 and 499, and they have a combined total of 25,893 students.
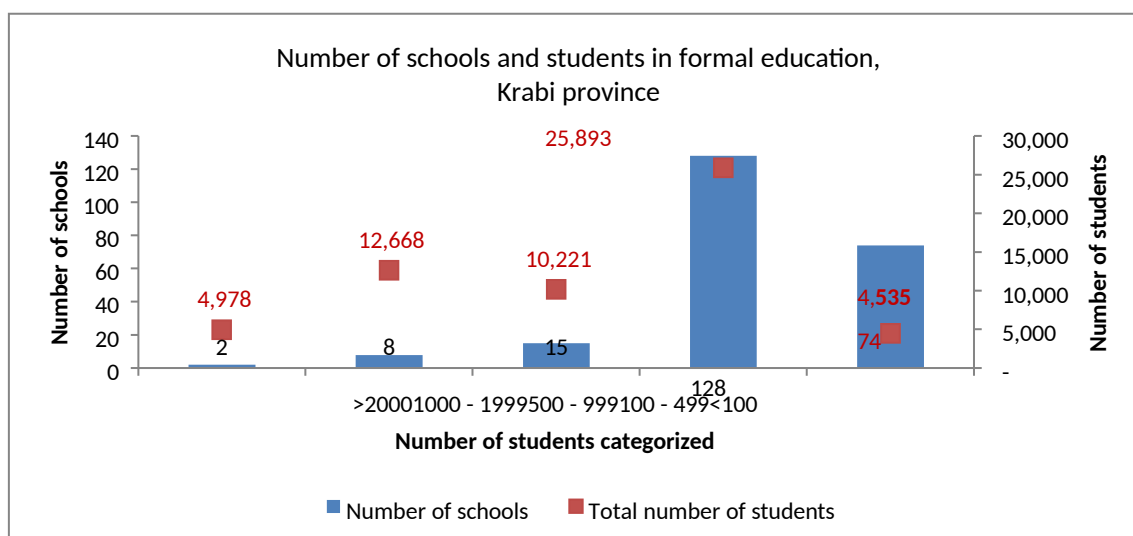
Figure 9: Number of schools and students in formal education, Krabi province
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018

b) Non-formal education

Number of students enrolled in non-formal education

Of the 33 schools offering non-formal education in the study area, 25 (76%) are in Nakhon Si Thammarat province, and 8 (24%) are in Krabi province. All the 33 schools provide non-formal education only for grades 6, 9 and 12. Overall, about two thirds of students enrolled in non-formal education are males. As shown in Figure 10 and Figure 11, Grade 6 has the least number of students enrolled, and grade 12 has the highest number of students enrolled.
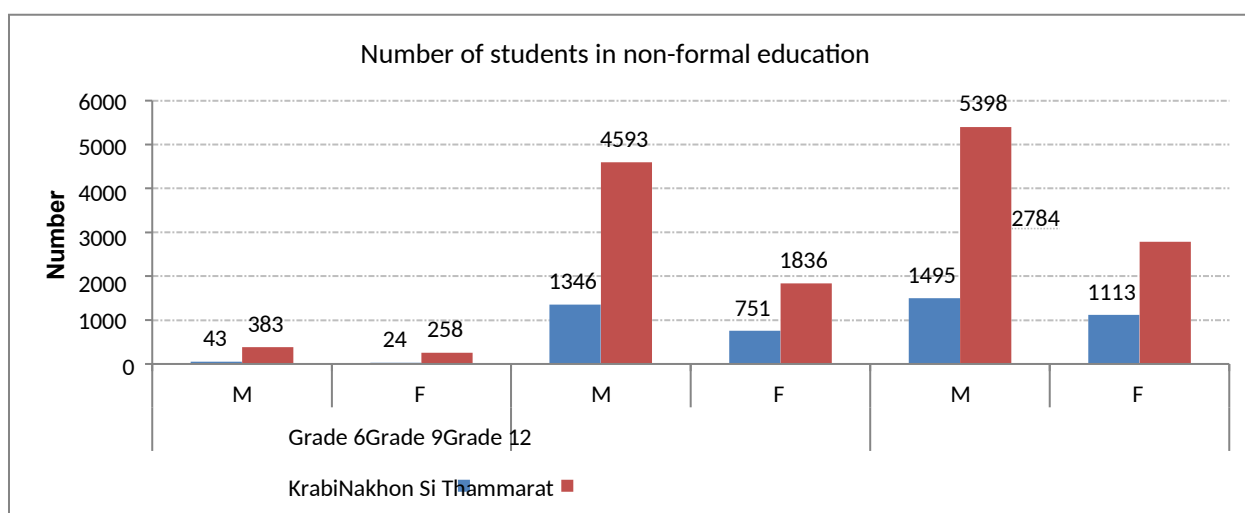
Figure 10: Number of students in non-formal education
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018
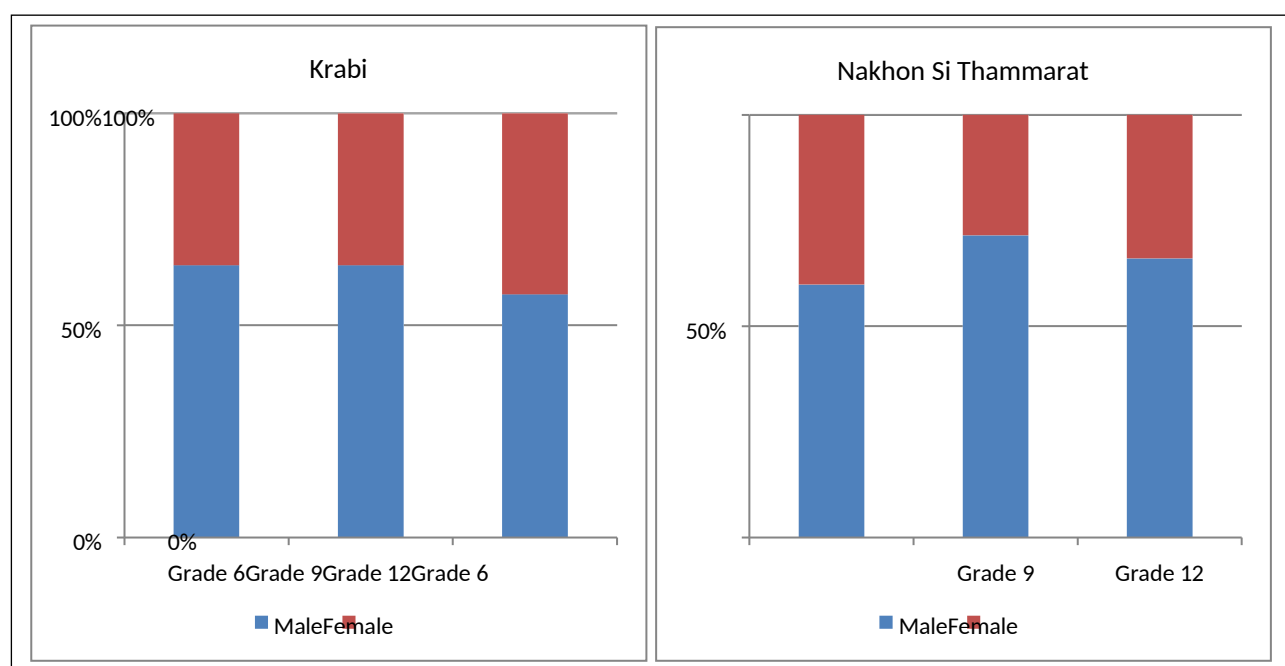
Figure 11: Distribution of students enrolled in non-formal education by gender
Source: Office of the Basic Education Commission (OBEC), Academic Year 2018

5.1.3 Health status

5.1.3.1 Female in-patients

Table 3 shows diseases/conditions among females that have in-patient rates greater or equal to 1,000 cases per 100,000 population. Only 6 conditions in Nakhon Si Thammarat province had that case rate in 2016, compared to 10 conditions in Krabi. In both provinces, endocrine, nutritional and metabolic disorders had the highest number of cases reported per 100,000 population among females.

Table 3: Rates of female in-patients per 100,000 population, 2016

Causes (diseases/groups of diseases)	Krabi	Nakhon Si Thammarat
Other Endocrine, nutritional and metabolic disorders	3,224	3,075
Essential (primary) hypertension	1,787	1,974
Persons encountering health services for other reasons	2,098	1,564
Other complications of pregnancy and delivery	2,080	1,273
Diabetes mellitus	1,241	1,258
Other symptoms, signs and abnormal clinical and laboratory findings, not Elsewhere classified	1,007	1,247
Other anaemia	1,049	965
Liveborn infants according to place of birth	1,295	934
Single spontaneous delivery	1,005	895
Other maternal care related to fetus and amniotic cavity and possible delivery problems	1,027	704

Source: Central office for Healthcare Information (CHI) and National Health Security Office (NHSO), 2016

5.1.3.2 Male in-patients

As shown in Table 4, fewer conditions among males had case rates above 1,000 per 100,000 population among males in both Krabi and Nakhon Si Thammarat province. In both provinces, endocrine, nutritional and metabolic disorders had the highest number of cases reported per 100,000 population in 2016.

Table 4: Rates of male in-patients per 100,000 population, 2016

Causes (diseases/groups of diseases)	Krabi	Nakhon Si Thammarat
Other Endocrine, nutritional and metabolic disorders	2,796	2,795
Essential (primary) hypertension	1,345	1,452
Other symptoms, signs and abnormal clinical and laboratory findings, not Elsewhere classified	1,088	1,237
Liveborn infants according to place of birth	1,333	1,010
Pneumonia	1,139	702

Source: Central office for Healthcare Information (CHI) and National Health Security Office (NHSO), 2016

5.1.4 Vulnerable groups

5.1.4.1 Children under the age of 1

The distribution of children under the age of 1 year in Krabi and Nakhon Si Thammarat provinces is shown in Figure 12. Mueang Krabi and Mueang Nakhon Si Thammarat contribute the largest proportions of children under 1 in Krabi and Nakhon Si Thammarat provinces respectively. In Nakhon Si Thammarat province, the 'others' include 27 sub-district municipalities, 2 town municipalities, 1 city municipality, and 14 District which account for 37% of children under 1 year in the province.
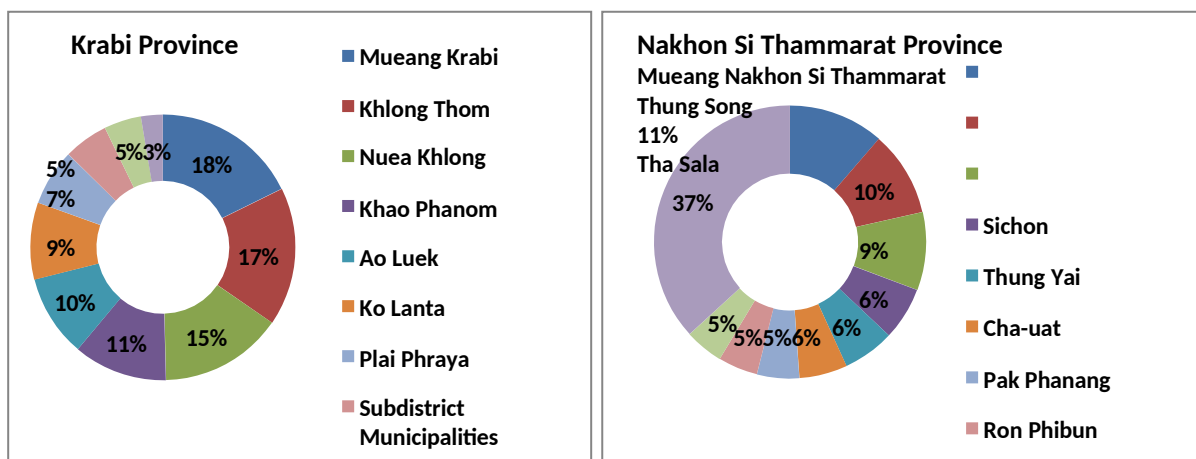
Figure 12: Distribution of children under 1 year in Krabi and Nakhon Si Thammarat provinces
Source: Department of Provincial Administration, Ministry of Interior, 2017

5.1.4.2 Children under 5 years

Figure 13 summarizes the distribution of children under the age of 5 in both Krabi and Nakhon Si Thammarat provinces. The two provinces have identical distribution of children under 5 in terms of proportions, with the 4 year age group constituting the largest proportion of 22%.
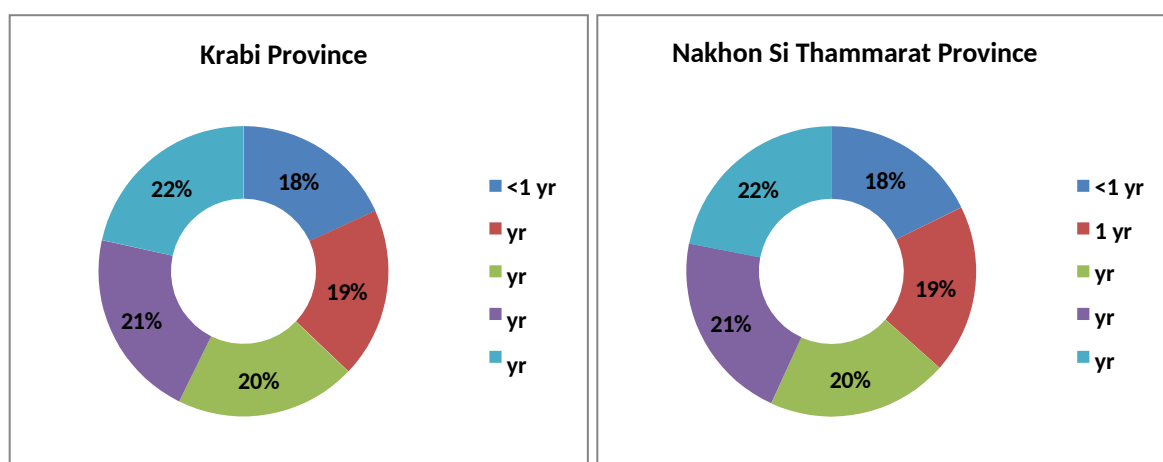
Figure 13: Distribution of children under 5 years
Source: Department of Provincial Administration, Ministry of Interior, 2017

5.1.4.3 Number of children under 5

As shown in
Figure 14, Mueang Krabi district has the highest number of children under the age of 5; and this is greater than the total for the sub-district municipalities and town municipality combined.
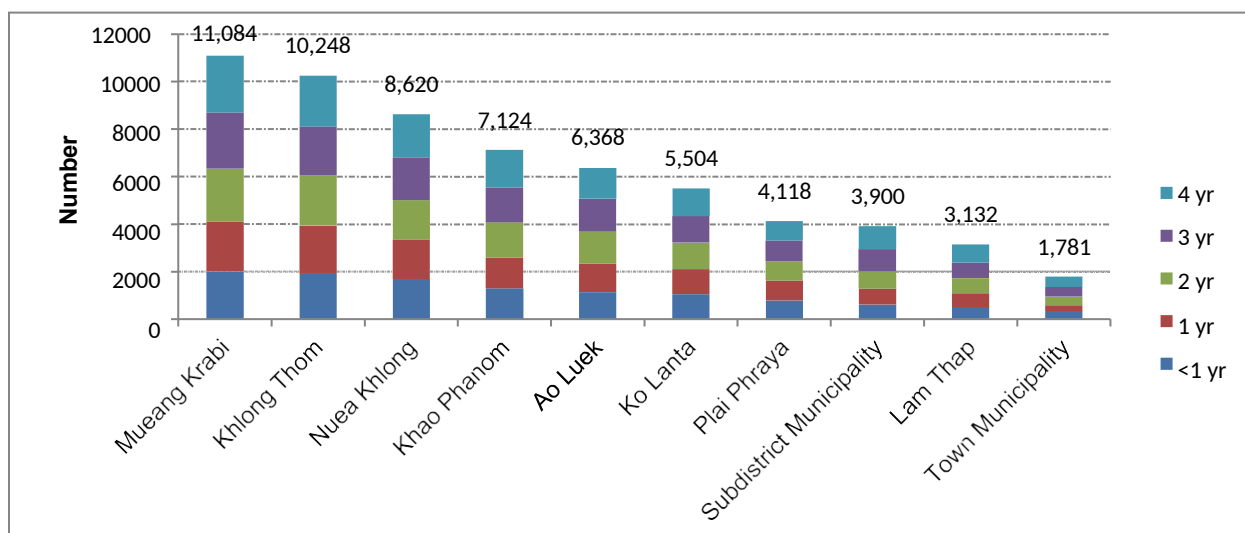
Figure 14: Number of children under 5 in Krabi province
Source: Department of Provincial Administration, Ministry of Interior, 2017

Figure 15 shows the numbers of children under 5 in Nakhon Si Thammarat province by administrative unit. Of the total 160,774 children under the age of 5 in Nakhon Si Thammarat province, Mueang Nakhon Si Thammarat contributes the highest proportion (11%) followed by Thung Song and Tha Sala contributing 9% each.
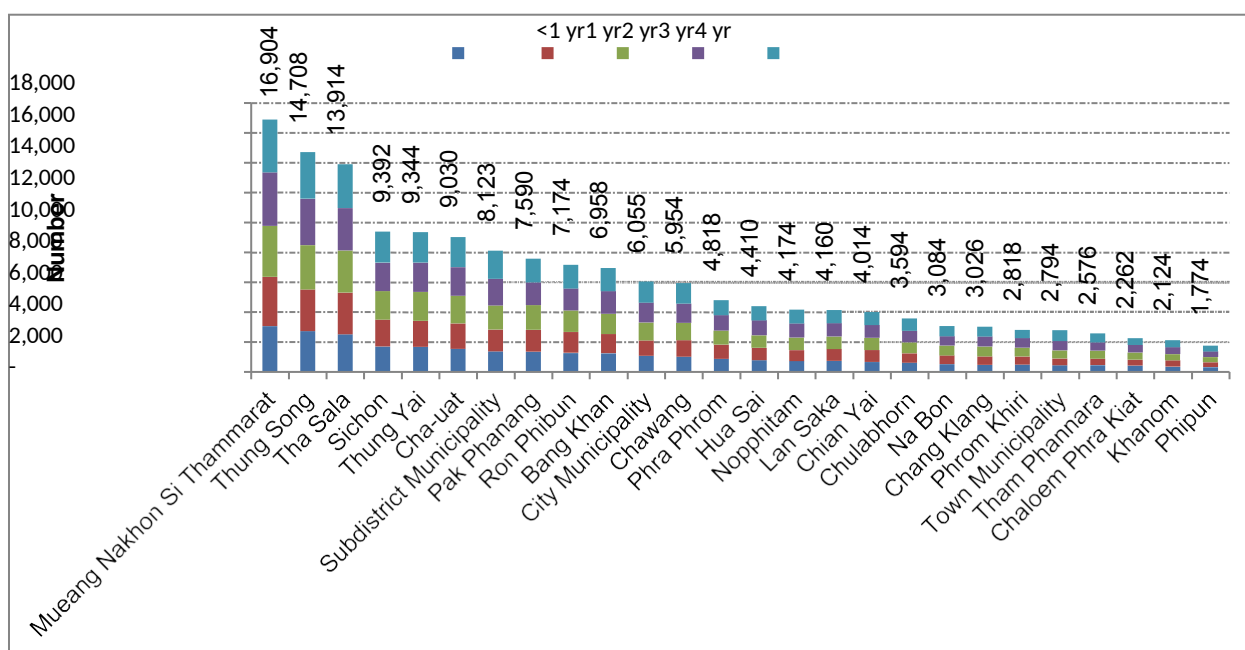
Figure 15: Number of children under 5 in Nakhon Si Thammarat province
Source: Department of Provincial Administration, Ministry of Interior, 2017

5.1.4.4 Elderly people

Elderly people in Krabi province
Figure 16 shows the distribution of elderly people aged 60 and above in Krabi province. Khlong Thom is the sub-district with the largest number of elderly people, and the town

municipality has the least number. However, the town municipality has the largest proportion (56%) females among the elderly.
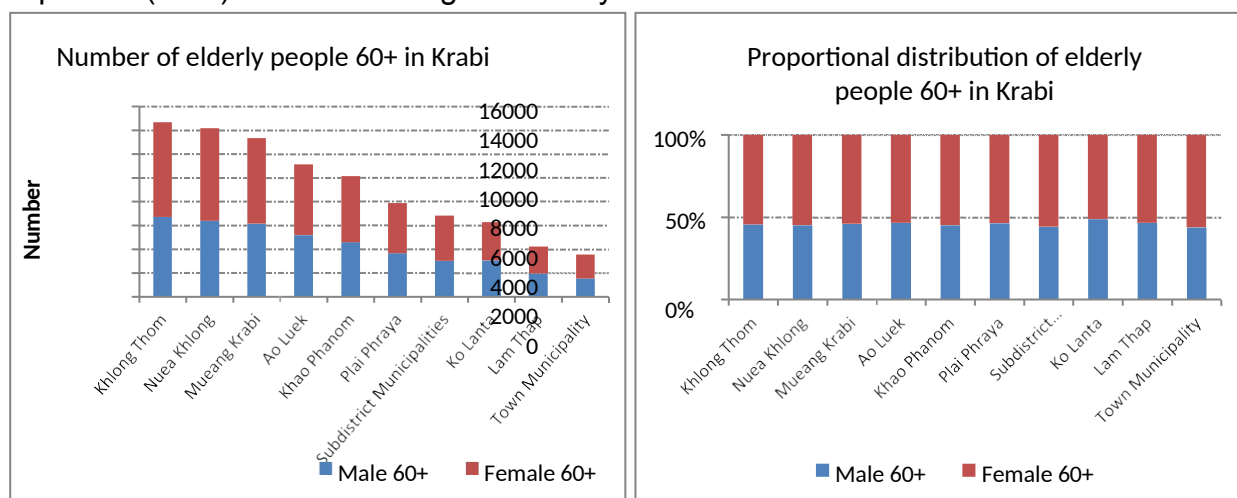
Figure 16: Distribution of elderly people aged 60+ in Krabi province
Source: Department of Provincial Administration, Ministry of Interior, 2017

Elderly people in Nakhon Si Thammarat province

Figure 17 and Figure 18 show the distribution of elderly people in Nakhon Si Thammarat province. Mueang Nakhon Si Thammarat sub-district has the largest number of elderly people (48,986). The proportional distribution of elderly people by gender in Nakhon Si Thammarat province is similar to that observed in Krabi province. Females aged 60+ outnumber their male counterparts with Chulabhorn district having the largest proportion (59%).
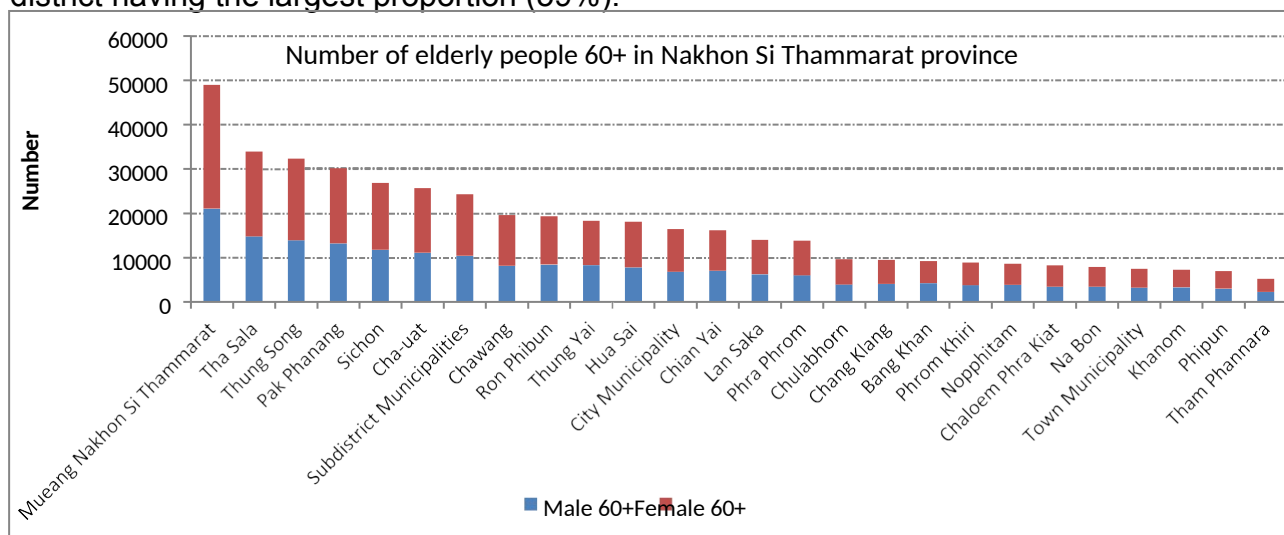
Figure 17: Number of elderly people 60+ in Nakhon Si Thammarat province
Source: Department of Provincial Administration, Ministry of Interior, 2017
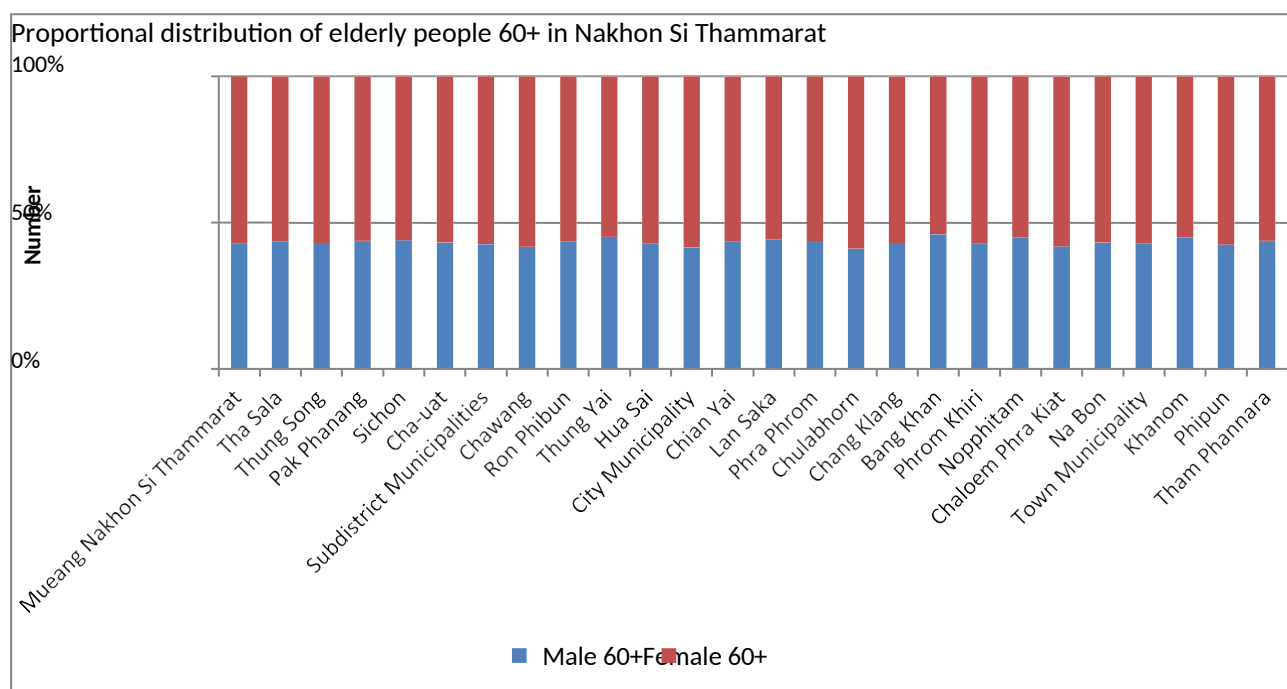
Figure 18: Proportional distribution of elderly people 60+ in Nakhon Si Thammarat province
Source: Department of Provincial Administration, Ministry of Interior, 2017.

5.1.4.5 Prisoners

Krabi province has only 2 prisons with a total of 2,582 prisoners, of which 2,289 (89%) are male and only 293 (11%) are female (Figure 19). The majority are already convicted.
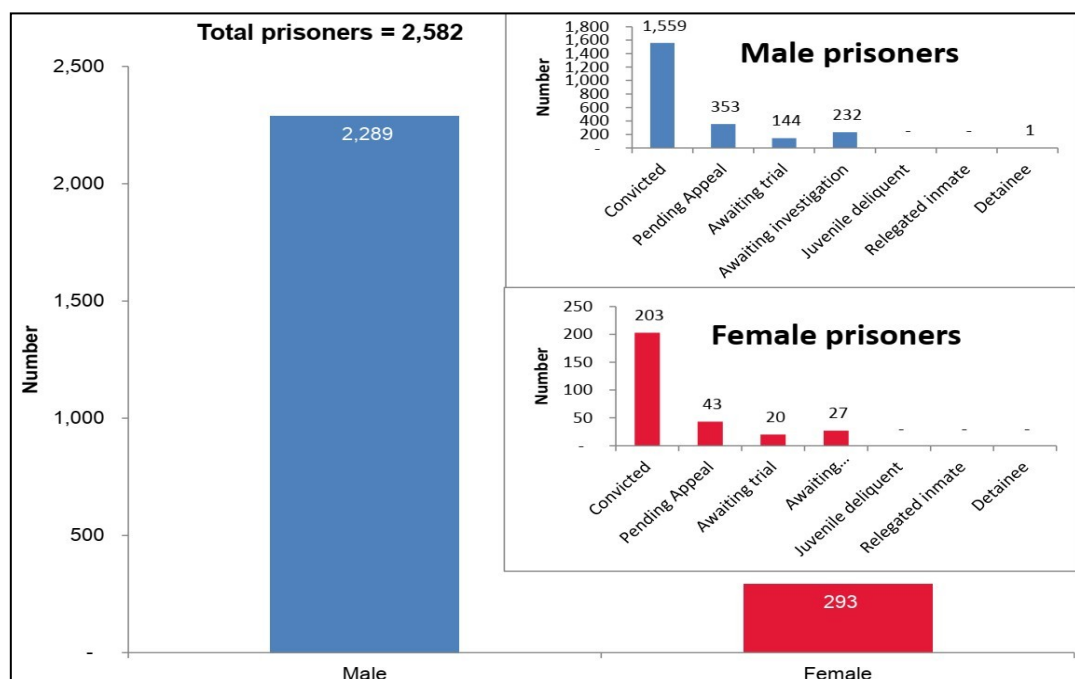
Figure 19: Number of prisoners in Krabi Province
Source: Department of Corrections, Ministry of Justice, March 2018

Nakhon Si Thammarat province, as of December 2018, has a total of 7 prisons. Of a total of 11,418 prisoners in the province, 10,177 (89%) are male and only 1,241 (11%) are female (Figure 20). The majority are already convicted.
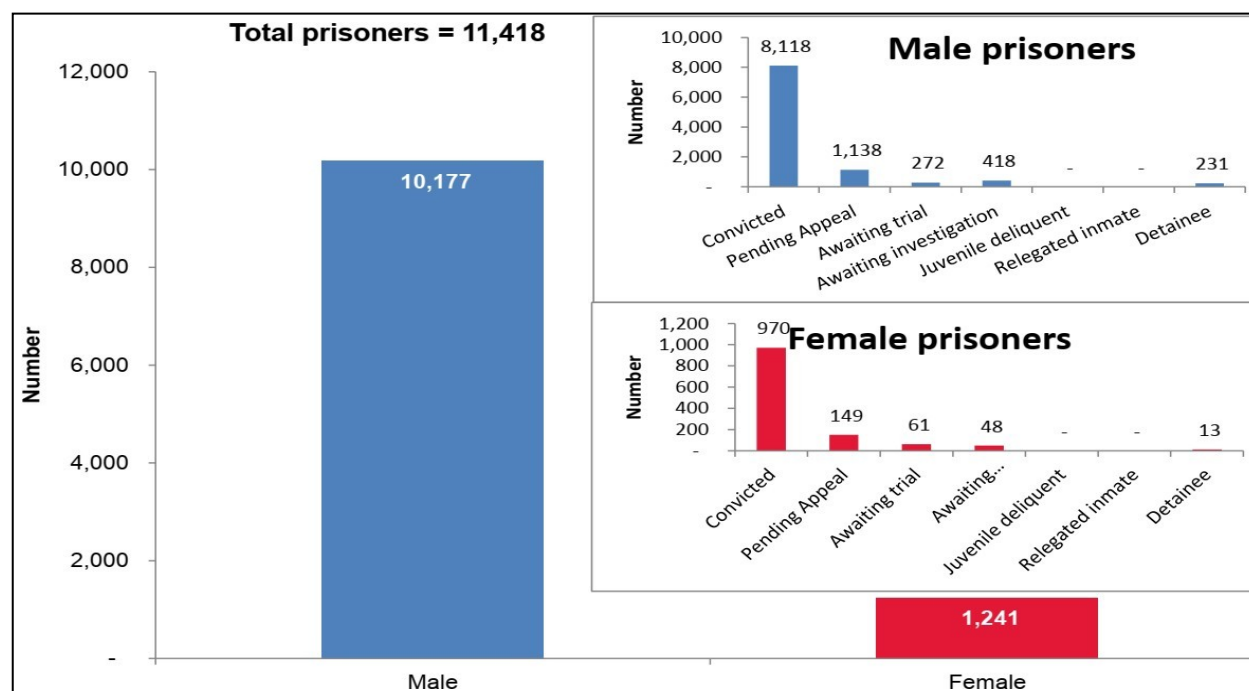
Figure 20: Number of prisoners in Nakhon Si Thammarat province
Source: Department of Corrections, Ministry of Justice, March 2018.

5.1.4.6 Orphan and homeless persons

As of 2019, a total of 6 homes for orphans and homeless persons were identified within the study area, and these had a total of 791 homeless persons. As shown in Table 5, 2 homes in Krabi province only had 40 persons, contributing just 5% to the total. Only Nakhon Si Thammarat Homeless People Protection Center provided a home to people above the age of 18. As shown in the table above, the majority of homeless persons 487 (62%) were aged 18-59 years, and housed at a home in Sichon district of Nakhon Si Thammarat province. Overall, the majority of homeless persons (71%) were males.

Table 5: Number of orphans and homeless persons

Province	District	Sub-district	Name	Age range (yr)	Males	Females	Total
Krabi	Mueang Krabi	Sai Thai	Krabi Shelter for Children and Families	0-18	3	12	15
	Town Municipality	Krabi Yai	Juvenile Observation and Protection Centre of Krabi Province	13-18	25	0	25
Nakhon Si Thammarat	City Municipality	Nai Mueang	Ban Si Thammarat Home for Boys	0-18	104 *	17 **	121
	Mueang Nakhon Si Thammarat	Bang Chak	Juvenile Observation and Protection Centre of Nakhon Si Thammarat Province	13-18	67	6	73
		Pak Nakhon	Nakhon Si Thammarat Shelter for Children and Families	0-18	36	34	70
People Protection Center	Sichon	Thung Sai	Nakhon Si Thammarat Homeless	18-59	325	162	487

* 84 Thai nationals and 20 persons without nationality
** 13 Thai nationals and 4 persons without nationality
Source: 1. Department of Children and Youth, Ministry of Social Development and Human Security;
2. Department of Juvenile Observation and Protection, Ministry of Justice

5.1.4.7 Disabled persons

As of January 2019, there were 78 people, and all females, with disabilities registered under the Centre for Empowerment and Vocational Development for Persons with Disabilities in Nakhon Si Thammarat Province (Figure 21). There was no Vocational Rehabilitation Centre in Krabi province at the time of data collection.
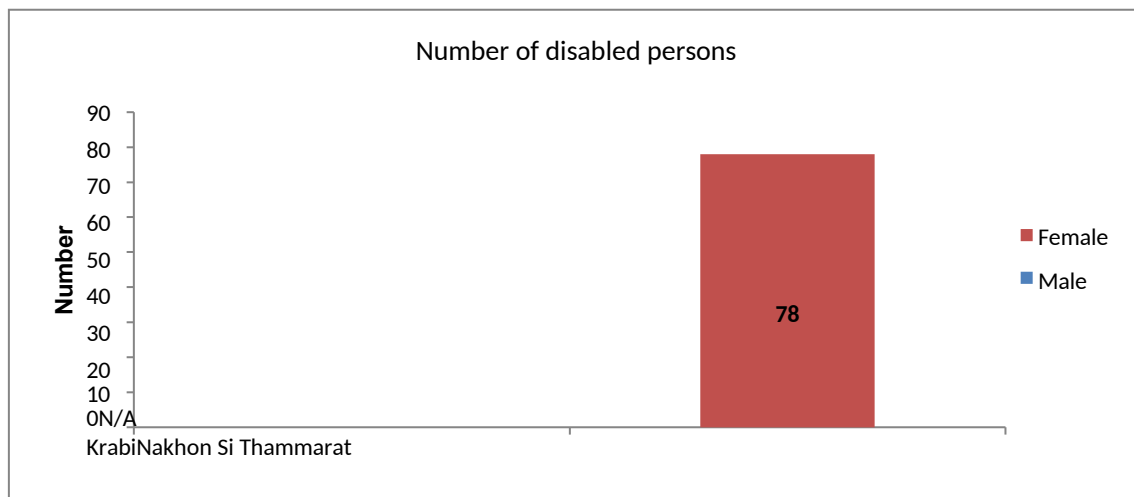
Figure 21: Number of disabled persons
Source: Office of the National Social Welfare Promotion Commission, Department of Social Development and Welfare, Ministry of Social Development and Human Security, 2019

Disabled persons: Krabi Provincial Public Health Office

Figure 22 shows the number and proportional distribution of disabled persons by type of disability in Krabi province. Data from the Krabi Provincial Public Health Office shows that there are a total of 3,806 disabled persons in 10 districts, out of which Mueang Krabi District has the largest number (1,119), constituting 29% of the total disabled persons in the district. Overall, physical disabilities constitute the largest proportion (46%) of all disability types recorded in Krabi province. However, in two of the 10 districts, that is, Nuea Khlong and Khao Phanom, physical disabilities constitute more than half (51%) of the total disabilities reported.
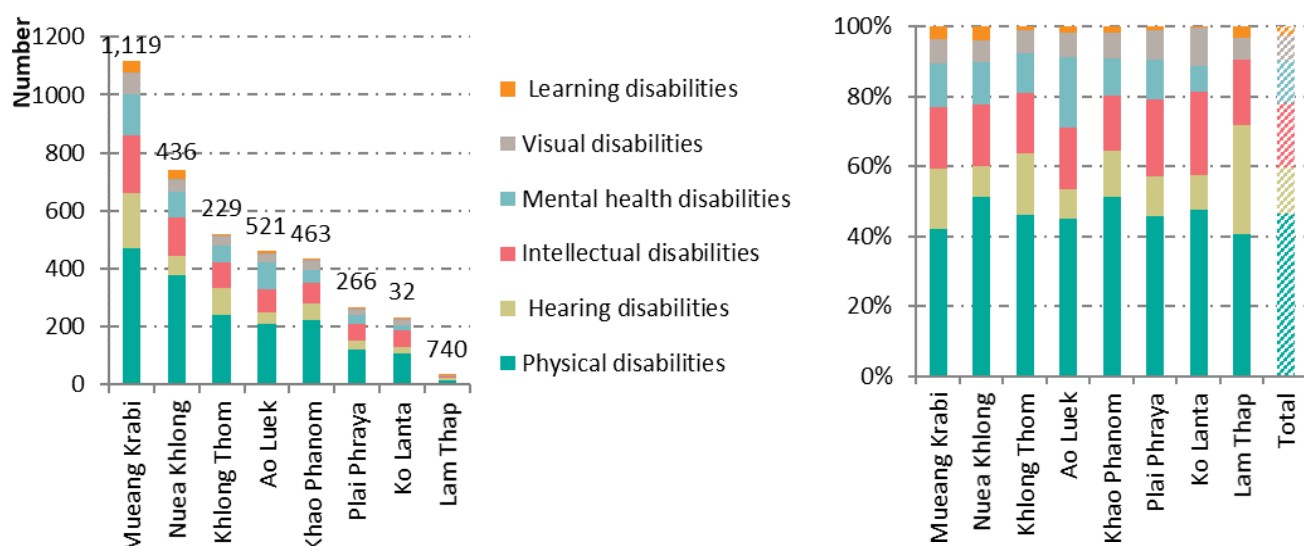
Figure 22: Disabled persons
Source: Krabi Provincial Public Health Office, Ministry of Public Health, 2019

Disabled persons: Nakhon Si Thammarat Provincial Public Health Office

As shown in
Figure 23, Nakhon Si Thammarat Province had a total of 11,592 disabled persons reported at 27 hospitals from 24 districts. Out of these, more than half (55%) are males. Tha Sala district had the highest number of disabled persons (1,359), and Na Bon district had the least (115). Overall, in most districts, males outnumbered their female counterparts except for 4 districts namely Thung Song, Chaloem Phra Kiat, Sichon and Pak Phanang districts.
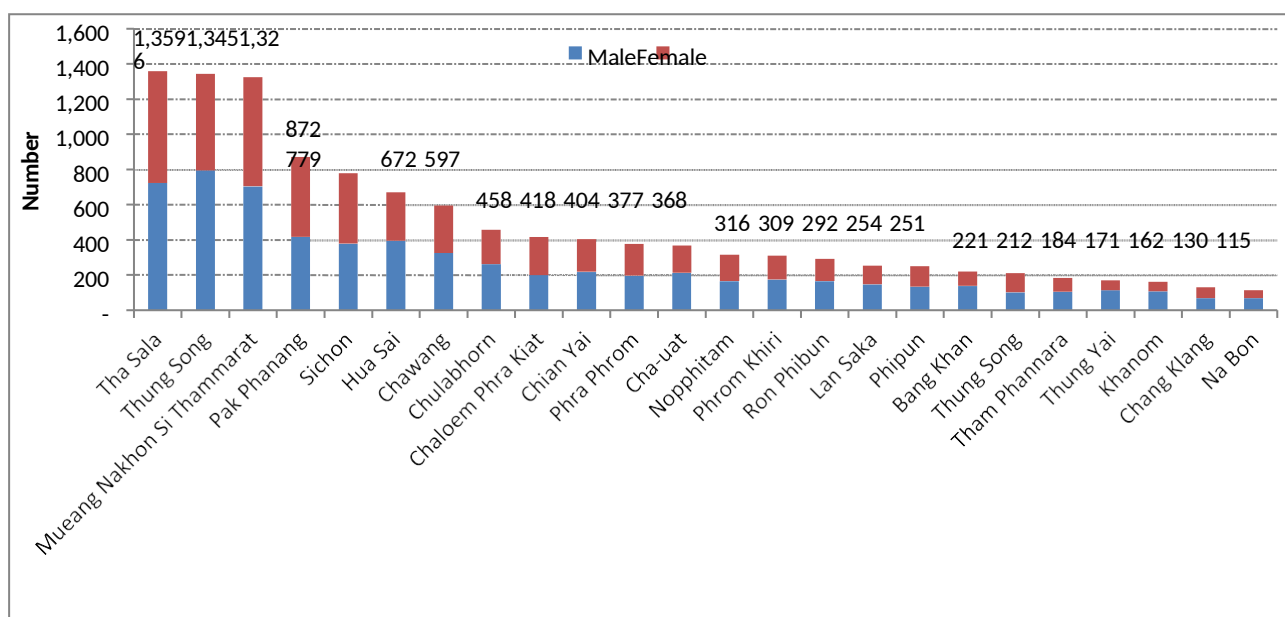
Figure 23: Disabled persons registry in Nakhon Si Thammarat province, fiscal year 2019
Source: Nakhon Si Thammarat Provincial Public Health Office, Ministry of Public Health, 2019

5.1.4.7 Patients with chronic diseases

We addressed four chronic diseases; kidney diseases, obstructive pulmonary disease, diabetes mellitus and hypertension, and stroke.

I.   Chronic kidney diseases

Chronic kidney diseases in Krabi province

Overall, there were 5,911 patients with chronic kidney disease in Krabi as of June 2019. Out of these Mueang Krabi had the highest number (1,120) constituting almost a fifth (19%) of the total CKD patients in Krabi district. This was followed by Khlong Thom and Nuea Khlong with 987 and 867 patients, respectively. As shown in Figure 24, district with the least number of patients was Lam Thap with 266 patients. Across the districts in Krabi, 13-39% were at stage 2, while 29-62% were already categorized at stage 3 based on the eGFR scores.
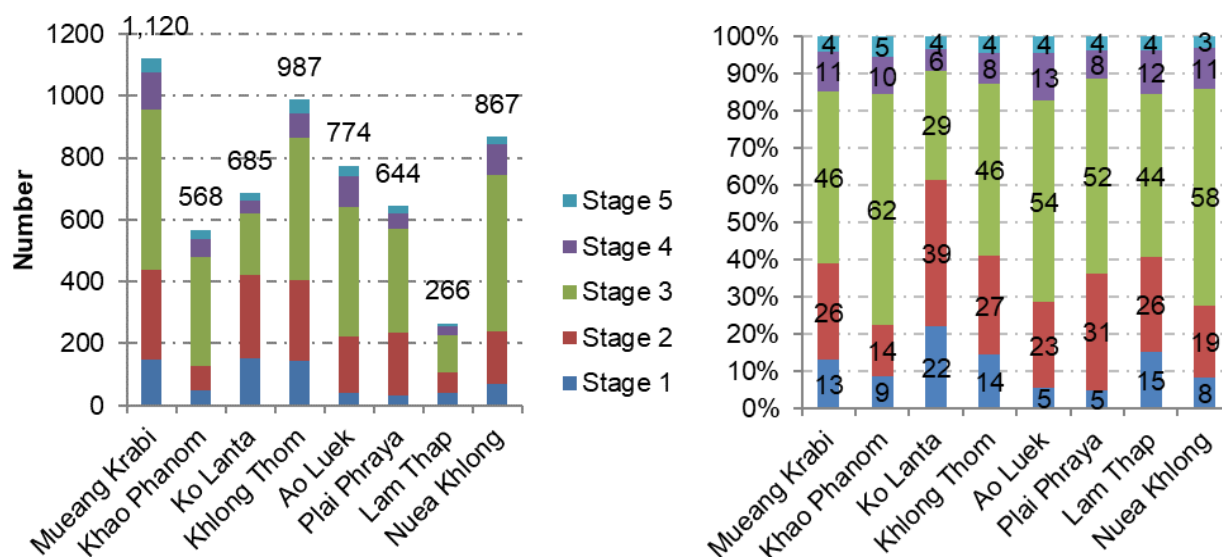
Figure 24: Distribution of chronic kidney disease by stage in Krabi province
Source: Krabi Provincial Public Health Office, Ministry of Public Health, 2019

Chronic kidney diseases in Nakhon Si Thammarat province

As of 2019, there were a total of 5,848 persons with chronic kidney disease in Nakhon Si Thammarat Province. Out of these, 22% came from only 2 out of the 18 districts and these included Thung Song (654) and Thu Sala 640). As shown in Figure 25, the least number of persons with chronic kidney disease came from Tham Phannara district (81).

Figure 25: Number of patients with chronic kidney disease in
Nakhon Si Thammarat province
Source: Nakhon Si Thammarat Provincial Public Health Office, Ministry of Public Health, 2019

II.   Chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease (COPD) patients in Krabi province

As shown in
Figure 26, a total of 1,133 COPD patients were reported across 8 districts in Krabi province. Out of these the highest number of patients (308) came from Ao Luek District, followed by Khao Phanom district with 225 patients, and the least (10) were reported in Nuea Khlong district. Overall, across the districts, at least 68% of the COPD patients were aged 60 years and above.
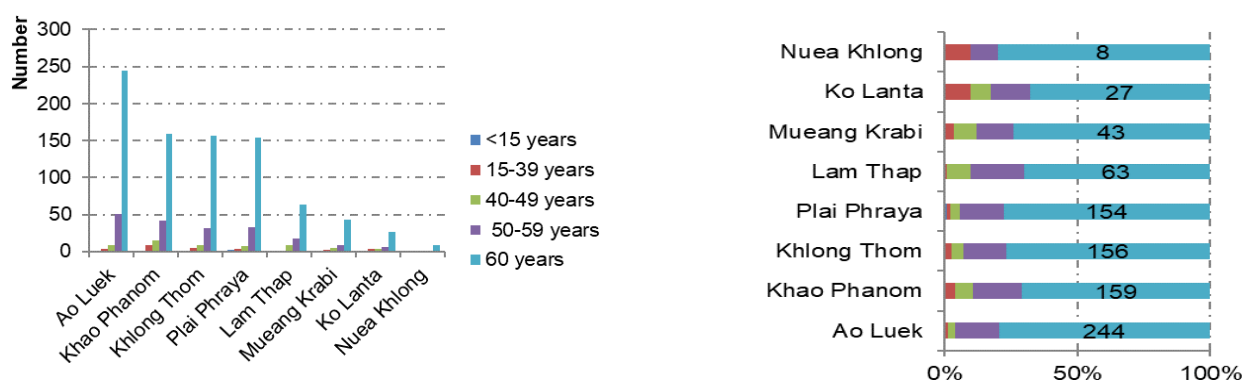
Figure 26: Distribution of COPD patients, Krabi province
Source: Krabi Provincial Public Health Office, Ministry of Public Health, 2019

Chronic obstructive pulmonary disease (COPD) patients in Nakhon Si Thammarat province

As of 2019, there were 3,418 chronic obstructive pulmonary disease (COPD) patients in Nakhon Si Thammarat province (Figure 27). Out of these, the highest number of patients (743) were reported in Sichon District and constituted 22% of the total COPD patients. Thung Song district had the second highest number (362) constituting 11% of the total. The district with the least number of COPD patients was Phra Phrom with only 27.
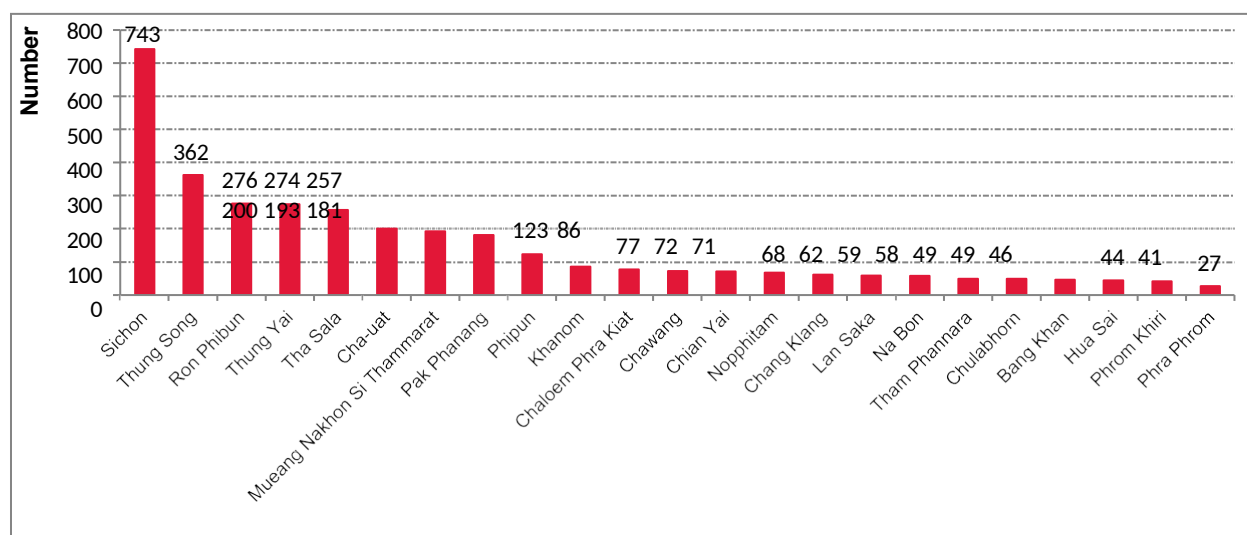
Figure 27: Distribution of COPD patients, Nakhon Si Thammarat province.
Source: Nakhon Si Thammarat Provincial Public Health Office, Ministry of Public Health, 2019.

III. Diabetes mellitus and hypertension

Diabetes mellitus and hypertension patients in Krabi province

A total of 84 heath facilities provided data on patients for diabetes, hypertension, and diabetes/hypertension co-morbidity. Mueang Krabi had the highest numbers of patients with diabetes and hypertension. Across the districts, there were at least 5 hypertensive patients for every case of diabetes mellitus reported (
Figure 28).
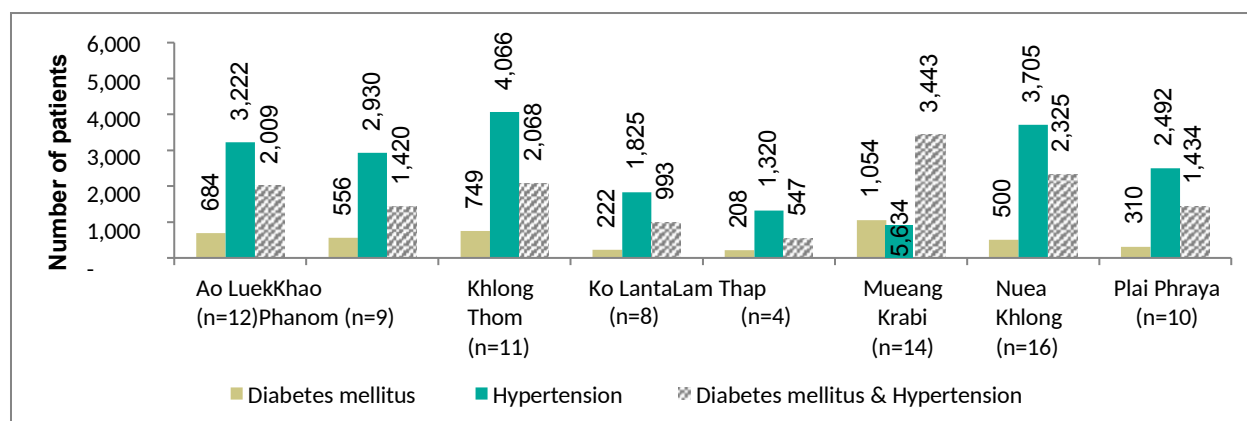
Figure 28: Number of diabetes mellitus and hypertension patients in Krabi province
Source: Krabi Provincial Public Health Office, Ministry of Public Health, 2019

Diabetes mellitus and hypertension patients in Krabi province

In Nakhon Si Thammarat province, there were 17,214, 97,014 and 45,392 patients for diabetes, hypertension, and diabetes/hypertension co-morbidity, respectively. Thung Song district had the highest numbers of patients with diabetes (2,080), while Mueang Nakhon Si Thammarat district had the highest numbers of hypertensive patients (10,732) and patients with diabetes/hypertension co-morbidity (5,796; Figure 29). Across the districts, there were at least 4 hypertensive patients for every case of diabetes mellitus reported.
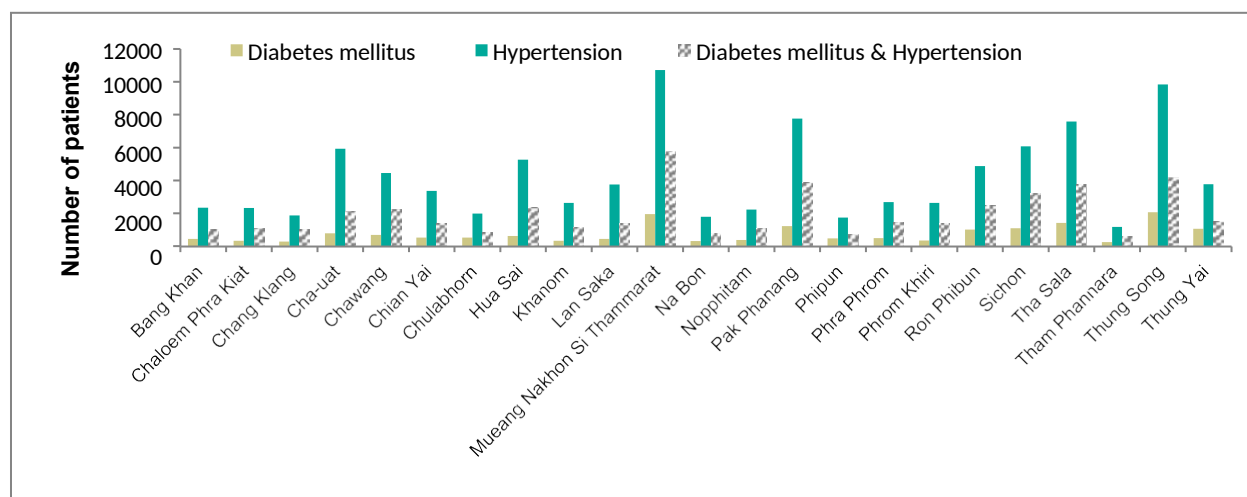
Figure 29: Number of diabetes mellitus & hypertension patients in Nakhon Si Thammarat province
Source: Nakhon Si Thammarat Provincial Public Health Office, Ministry of Public Health, 2019

IV.   Stroke

### Stroke patients in Krabi province

As of 2019, a total of 1,545 stroke patients were reported across 8 districts in Krabi province. Out of these the highest number of patients (614) came from Ao Luek District, followed by Khao Phanom district with 361 patients, and the least (9) were reported in Lam Thap district (Figure 30). Overall, across the districts, the majority of at least 64% of the stroke patients were aged 60 years and above.

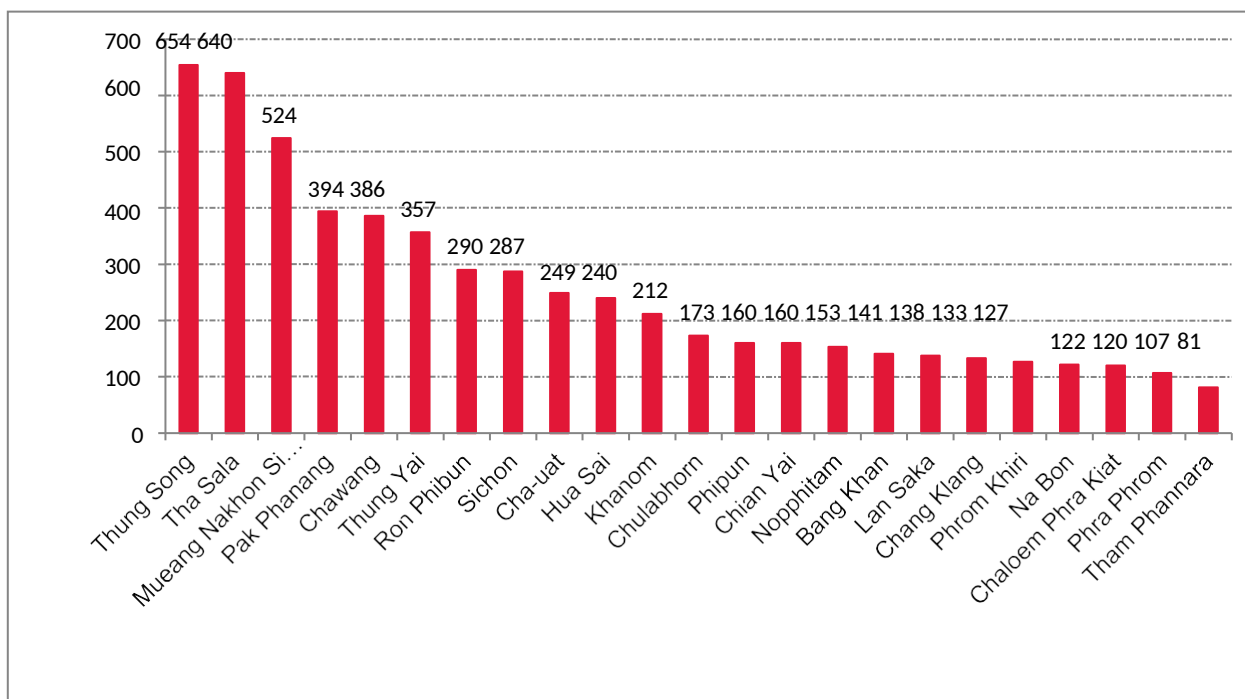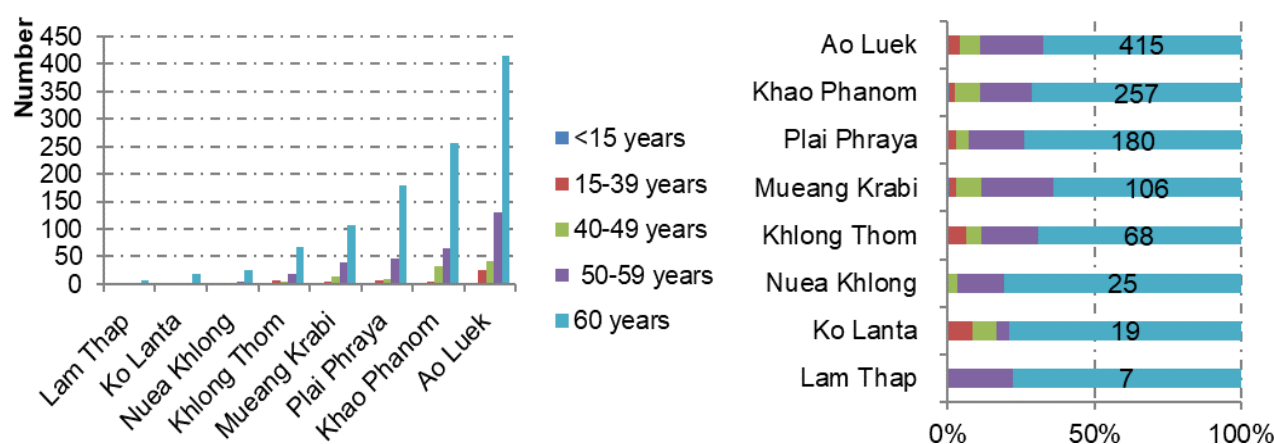
Figure 30: Distribution of stroke patients by age group in Krabi province
Source: Krabi Provincial Public Health Office, Ministry of Public Health, 2019

Stroke patients in Krabi province

As shown in Figure 31, there were 5,071 stroke patients in Nakhon Si Thammarat province. Out of these, the highest number of patients (757) were reported in Sichon District and constituted 15% of the total stroke patients. Thung Song district had the second highest number (748) also constituting 15% of the total. The district with the least number of stroke patients was Chaloem Phra Kiat with only 40 (1%).
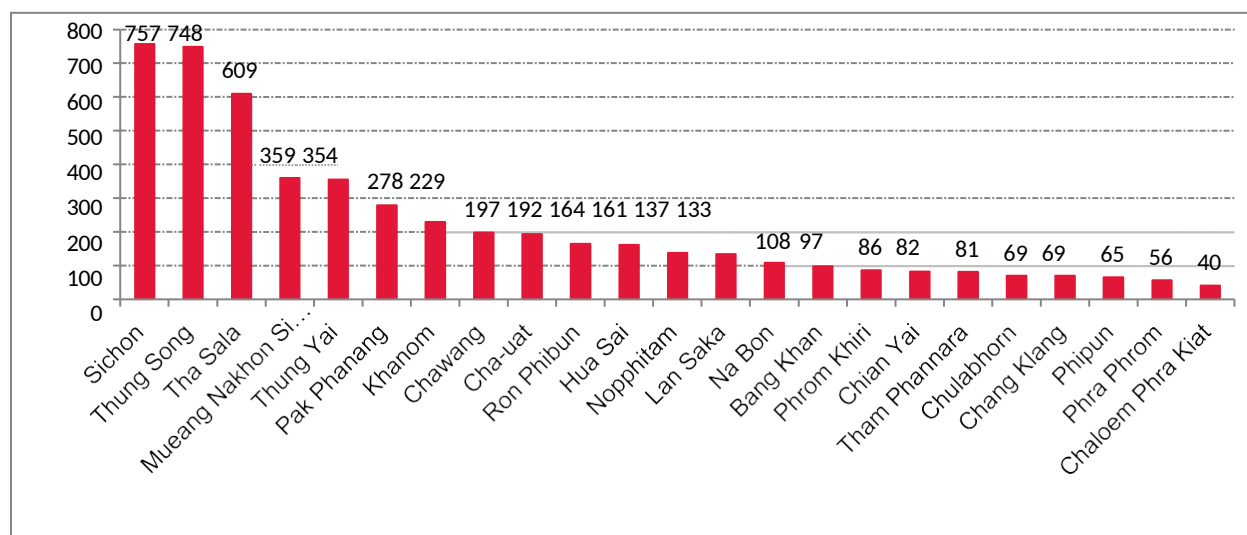
Figure 31: Distribution of stroke patients in Nakhon Si Thammarat province.
Source: Nakhon Si Thammarat Provincial Public Health Office, Ministry of Public Health, 2019.

5.1.5 Public health resources

5.1.5.1 Health care workers by type of administration

In both Krabi and Nakhon Si Thammarat provinces, the largest proportion of the health workforce is under the Ministry of Public Health, followed by the private sector. As shown in Table 6, the majority of health care workers are professional nurses, followed by public health technical officers. In addition, professional nurses are the only cadres available under independent organizations, but only for Nakhon Si Thammarat province. The least number of health workers available in both provinces, and across all types of administration, are psychologists.

5.1.5.2 Medical specialists

Table 7 shows the numbers of the available medical specialists by province. In Nakhon Si Thammarat, the majority of medical specialists fall under the Anesthesiology group (76), while in Krabi province, specialists under the surgery group are the majority (17). Within the study area, there is only one pathologist who is in Nakhon Si Thammarat province.

Table 6: Number of health workers by type of administration, 2017

	Ministry of public health		Other ministries		Private		Local government		Independent organizations	
	Krabi	Nakhon Si Thammarat	Krabi	Nakhon Si Thammarat	Krabi	Nakhon Si Thammarat	Krabi	Nakhon Si Thammarat	Krabi	Nakhon Si Thammarat
Dentists	56	138	0	13	6	17	0	7	0	0
Doctors	126	444	0	27	13	37	0	19	0	0
Medical Technologists	26	88	0	12	0	14	9	4	0	0
Pharmacists	73	205	0	13	6	17	0	7	0	0
Physiotherapists	20	55	0	6	5	7	0	4	0	0
Professional Nurses	788	2398	2	84	54	110	2	79	0	8
Psychologists	3	3	1	0	0	0	0	0	0	0
Public Health Technical Officers	311	668	0	0	0	1	0	5	0	0
Radiological Technologists	6	24	0	0	1	5	0	0	0	0
Technical Nurses	6	28	0	0	1	4	0	0	0	0
Thai Traditional Medical Doctors	26	25	0	4	2	0	0	8	0	0

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Table 7: Number of medical specialists by province

Specialist	Krabi	Nakhon Si Thammarat	Whole Country
Anesthesiology	8	76	4796
Medical Specialists (Medicine Group)	8	27	2084
Medicine Group	16	59	6223
Obstetrics & Gynecology	6	25	2138
Ophthalmology, Psychiatry, Forensic Medicine, Otolaryngology	9	35	2886
Pathology	0	1	388
Pediatrics	7	28	2721
Radiology	3	11	1462
Surgery	17	41	4928
Total	**74**	**303**	**27626**

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Ratio of medical specialists per 100,000 population

Across all categories of specialists, the ratios per 100,000 population in either Krabi or Nakhon Si Thammarat province are lower than the ratios at national level. In addition, for all categories of medical specialists, except the surgery group, Nakhon Si Thammarat province has higher ratios of medical specialists per 100,000 population than Krabi province (Figure 32).
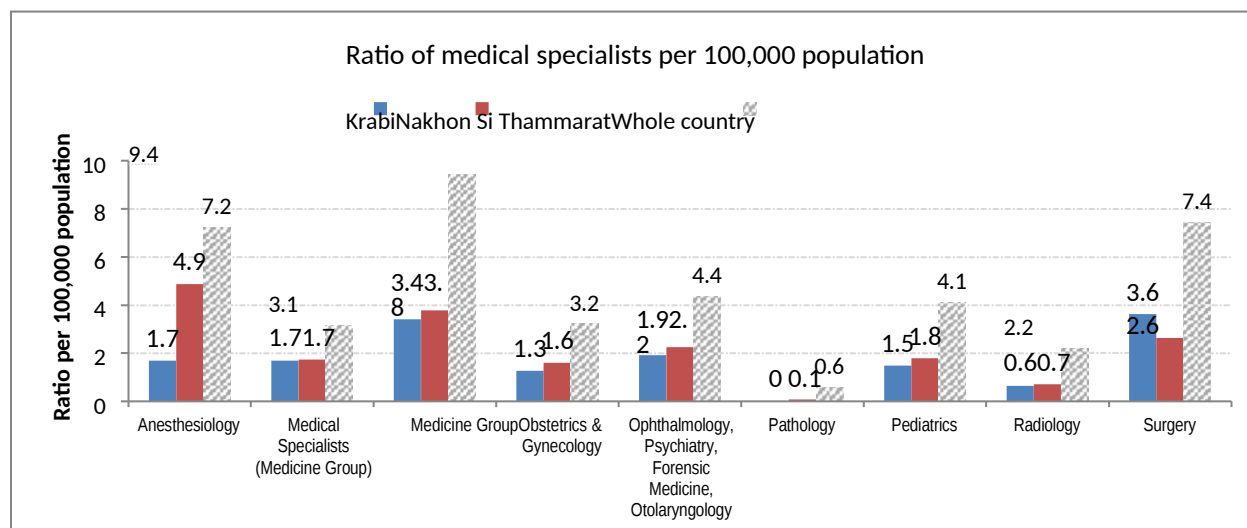
Figure 32: Ratio of medical specialists per 100,000 population
Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.5.3 Health personnel at different levels

In Krabi province, pharmacists and medical doctors are concentrated at the lowest, District, level, i.e., at District Health Promoting Hospitals (DHPHs). As shown in Figure 33, the majority of health personnel in Krabi province are professional nurses, of which the majority are stationed at community level hospitals (371), followed by general level hospitals (303), then DHPHs with a total of 113. Krabi province does not have a regional level hospital.

Number of health personel, Krabi Province

	Technical Nurses	Dentists	Pharmacists	Doctors	Professional Nurses 113
DHPH	- 2	21	100	160	371
Community	4	40	39	68	303
General		14	26	58	
Regonal					
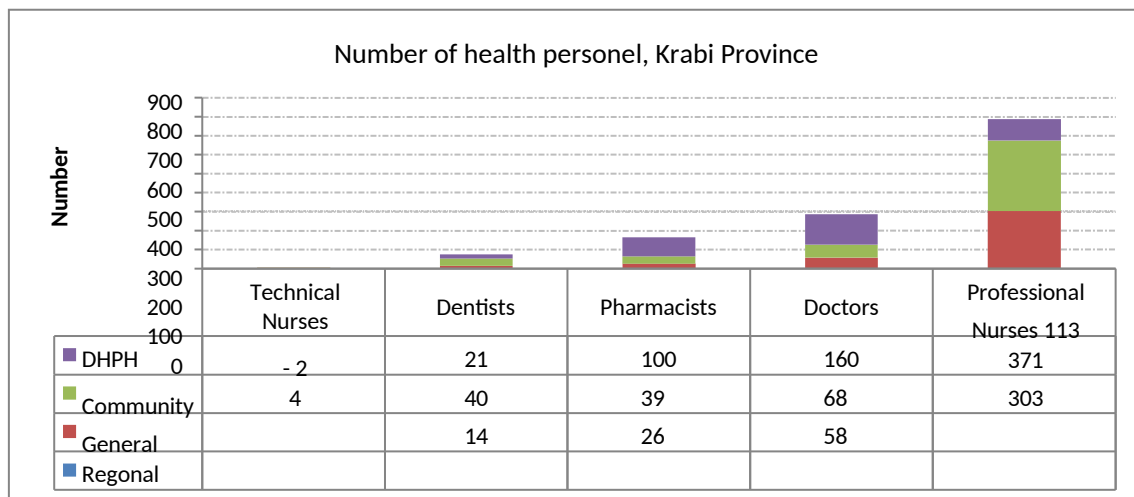
Figure 33: Number of health personnel available at different levels, Krabi province
Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Similarly, In Nakhon Si Thammarat province, pharmacists and medical doctors are also concentrated at the DHPHs. Majority of professional nurses in Nakhon Si Thammarat province are stationed at regional and community level hospitals as shown in Figure 34.

Number of health personnel, Nakhon Si Thammarat province

	Technical Nurses	Dentists	Pharmacists	Doctors	Professional Nurses
DHPH	-	32	173	332	239
Community	9	93	106	235	799
General	-	23	39	95	467
Regonal	15	17	42	103	798

Figure 34: Number of health personnel available at different levels, Nakhon Si Thammarat province
Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.5.4 Health personnel in private hospitals

Figure 35 shows the distribution of health personnel within the private hospitals, and whether they work full time or part time. Less than half of the doctors and dentists within the private hospitals work full-time. Professional nurses constitute the majority of health workers working both full time and part time in private hospitals.
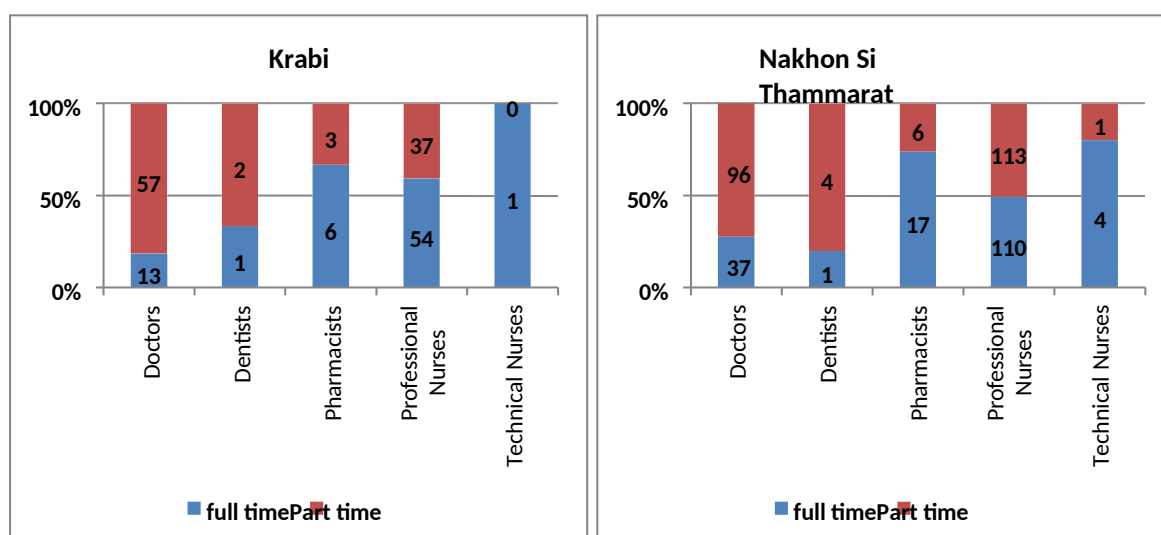
Figure 35: Distribution of health personnel available at private hospitals
Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.5.5 High-cost medical equipment

The commonest high-cost medical equipment in both Krabi and Nakhon Si Thammarat province are the ambulances. For all the high-cost medical equipment shown in Figure 36, Nakhon Si Thammarat province has at twice as much as Krabi province.

	Hemodialysis	Ambulance	Ultrasound	Computerized Tomography (CT) Scan	Extracorporeal Shock Wave Lithotripsy (ESWL)	Magnetic Resonance Imaging (MRI)	Gamma Nife
Krabi	16	43	27	4	1	1	1
Nakhon Si Thammarat	87	111	82	9	4	2	0
Whole Country	7,263	6,130	4,841	547	233	152	34
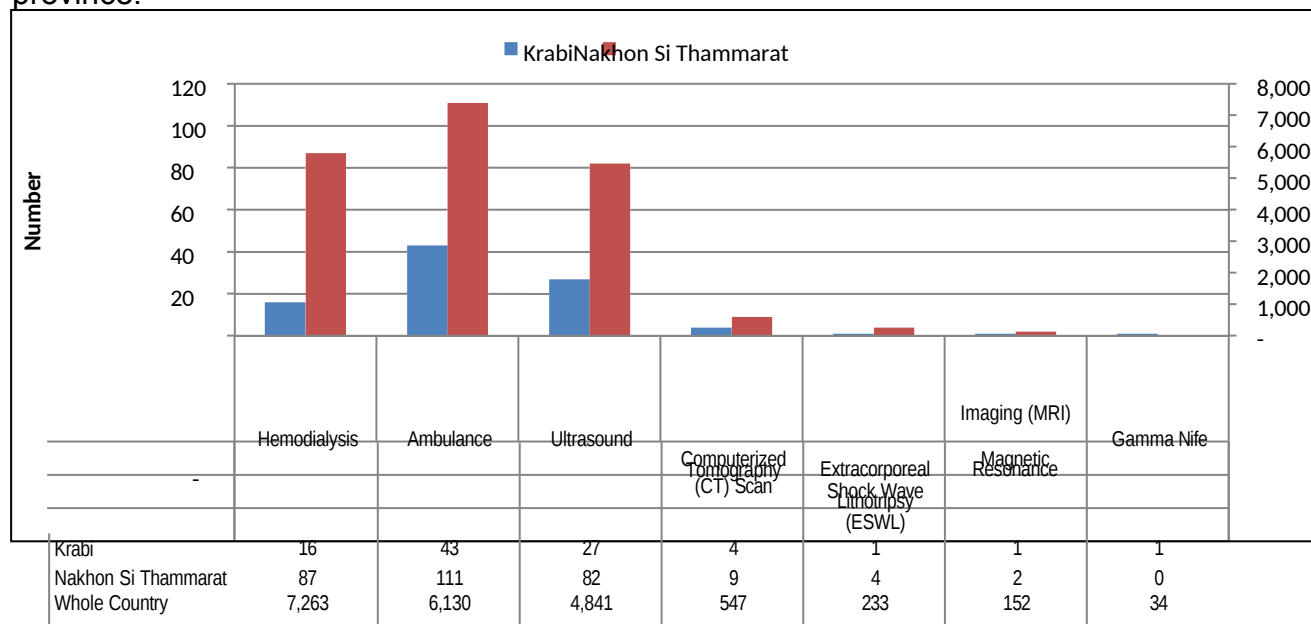
Figure 36: Number of high-cost medical equipment by province, 2017
Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.5.6 Hospitals and medical establishments with beds

Table 8 summarizes the number of hospitals and medical establishments with beds by type of administration in Krabi and Nakhon Si Thammarat provinces, as well as the whole country. Krabi has a total of 11 establishments with beds compared to a

total of
30 in Nakhon Si Thammarat province. Majority of such establishments in both

provinces fall under the jurisdiction of the Ministry of Public Health. This is the same trend even for the hospital beds. Only 733 beds are available in Krabi province compared to 2,584 in Nakhon Si Thammarat province. Krabi province has neither establishments with beds nor beds under any other ministry, independent organization or local government.

Table 8: Number of hospitals & medical establishments with beds by type of administration, 2017

	Whole Country		Krabi		Nakhon Si Thammarat	
	Hospitals with beds	Number of Beds	Hospitals with beds	Number of Beds	Hospitals with beds	Number of Beds
Ministry of Public Health	943	99,941	9	608	22	2,112
Other Ministries	87	15,336	0	0	2	125
Independent Organizations	7	1,070	0	0	1	10
Local Government	10	2,808	0	0	1	46
Private	308	31,684	2	125	4	291
Total	1,355	150,839	11	733	30	2,584

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018
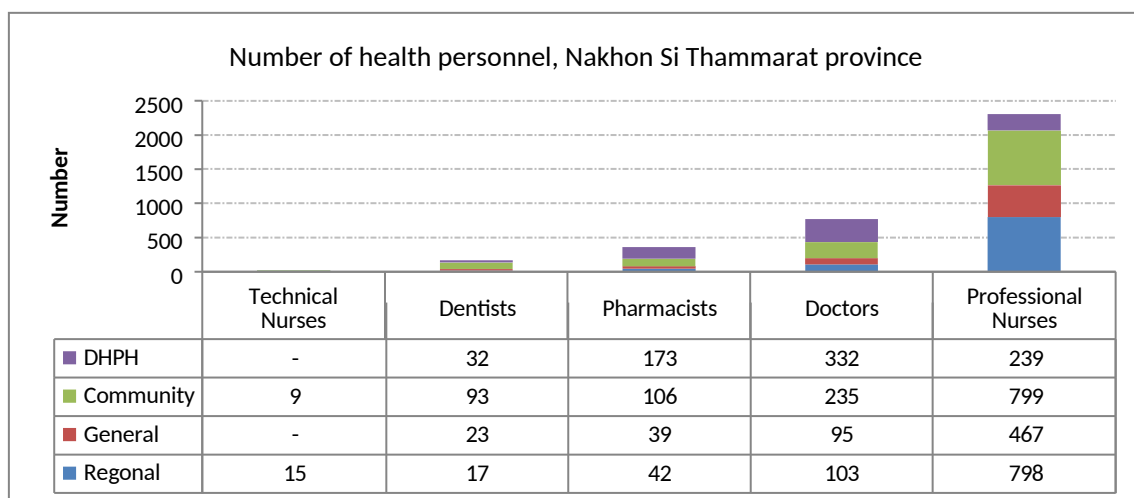
5.1.5.7 Beds by hospital level

Figure 37 gives a summary of hospitals or establishment with beds, as well as the number of beds available by type/level of hospital. In both Krabi and Nakhon Si Thammarat province, the majority of establishments with beds are community hospitals. However, most beds are concentrated at higher level hospitals. One general hospital in Krabi province has more beds (341) than the total beds available at the 8 community hospitals (267). As for Nakhon Si Thammarat province, majority of beds are located at the community hospitals, followed by the regional hospital, then the general hospitals.
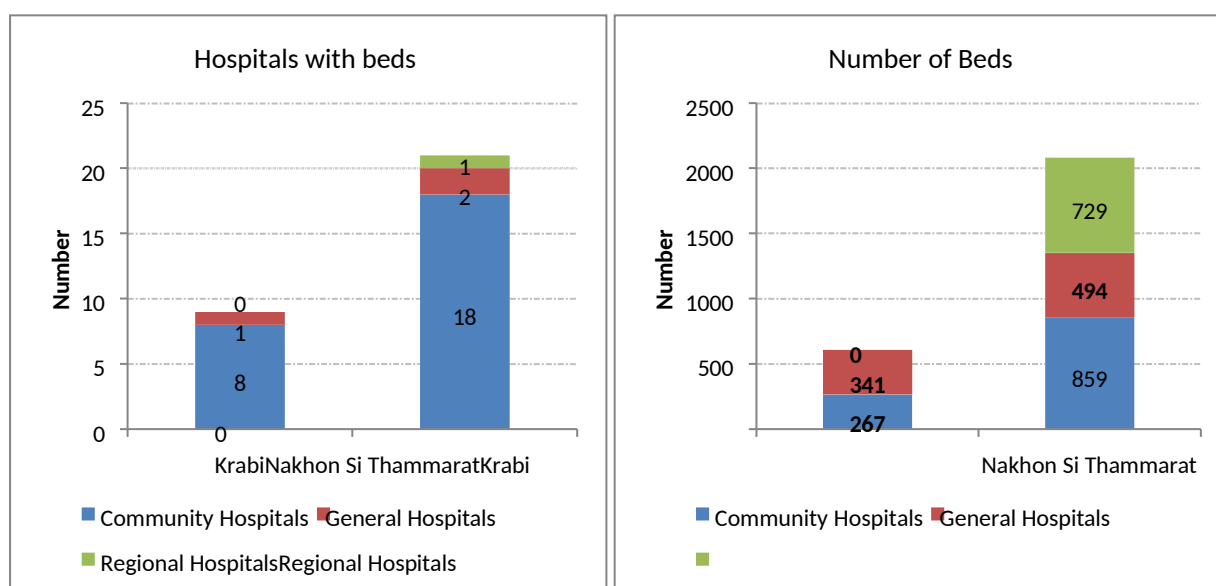
Figure 37: Number of region, general, and community hospitals, and beds, 2017

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.5.8 Total beds and patient volumes

Both Krabi and Nakhon Si Thammarat provinces have higher than national average ratios of bed per population as well as doctor per number of beds (Table 9). Patient volumes are much higher in Nakhon Si Thammarat compared to Krabi. As such, the bed occupancy rate, which refers to the proportion of beds occupied by patients in a year, is higher in Krabi (89%) than in Nakhon Si Thammarat province (83%).

Table 9: Number of beds, doctor per beds, patient volumes, and bed occupancy rate, 2017

Province	Whole Country	Krabi	Nakhon Si Thammarat
No. of Beds	150,839	733	2,584
Bed per Population	432	636	601
Doctor per number of beds	4	5	5
Outpatients	45,955,913	292,500	698,227
OPD Visits	214,646,889	914,341	3,148,559
Inpatients	10,098,736	67,766	210,354
Length of Stay	41,586,284	236,899	785,754
Bed Occupancy Rate	76	89	83

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Beds and patient volumes at regional hospitals

Table 10 shows the number of beds and patient volumes at regional hospitals. There is no regional hospital in Krabi province. At the level of regional hospitals, the ratios including doctor per number of beds and bed occupancy rate are higher in Nakhon Si Thammarat province compared to the national average.

Table 10: Number of beds and patient volumes at regional hospitals, 2017

Province	Whole Country	Krabi *	Nakhon Si Thammarat
No. of Beds	24,096		729
Bed per Population	2,474		2,131
Doctor per number of beds	4		7
Outpatients	6,084,949		156,019
OPD Visits	23,242,335		626,025
Inpatients	1,714,834		53,787
Length of Stay	8,192,174		267,941
Bed Occupancy Rate	93		101

* No regional hospital in Krabi province
Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Beds and patient volumes at general hospitals

At general hospitals, Nakhon Si Thammarat has a better the ratio in terms of doctor per number of beds compared to both Krabi province and the national average. Bed occupancy rate is higher in Krabi province compared to Nakhon Si Thammarat province. Outpatients and OPD visits recorded at general hospitals in Krabi province in 2017 were higher than those recorded at general hospitals in Nakhon Si Thammarat province (Table 11).

Table 11: Number of beds and patient volumes at general hospitals, 2017

Province	Whole Country	Krabi	Nakhon Si Thammarat
No. of Beds	26,436	341	494
Bed per Population	28,134	1,367	3,144
Doctor per number of beds	6	6	5
Outpatients	6,132,268	24,343	23,196
OPD Visits	26,789,542	275,102	202,506
Inpatients	1,873,970	31,818	46,276
Length of Stay	8,493,211	134,642	179,607
Bed Occupancy Rate	88	108	100

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Beds and patient volumes at community hospitals

At community hospitals, Nakhon Si Thammarat and Krabi province both have the same ratio of doctor per number of beds as the national average. However, even at this level, the bed occupancy rate is still higher in Krabi (93%) compared to Nakhon Si Thammarat province (80%) as shown in Table 12.

Table 12: Number of beds and patient volumes at community hospitals, 2017

Province	Whole Country	Krabi	Nakhon Si Thammarat
No. of Beds	37,582	267	859
Bed per Population	1,735	1,746	1,808
Doctor per Bed	4	4	4
Outpatients	18,761,061	226,907	340,014
OPD Visits	77,507,517	595,328	1,568,566
Inpatients	3,173,442	32,226	79,431
Length of Stay	10,183,778	90,180	249,405
Bed Occupancy Rate	74	93	80

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

Beds and patient volumes at District Health Promoting hospitals (DHPH)

Table 13 summarizes the patient volumes recorded at DHPHs in 2017. Krabi province has less than half the number of DHPHs available in Nakhon Si Thammarat province. As such the patient volumes in terms of outpatients, OPD visits and average daily attendance are much higher in Nakhon Si Thammarat province.

Table 13: Patient volumes at district health promoting hospitals, 2017

Province	Whole Country	Krabi	Nakhon Si Thammarat
No. of DHPH	9,770	72	251
Outpatients	29,336,736	160,537	579,548
OPD Visits	119,417,831	852,029	2,491,501
Average Daily Outpatients	417,545	2,979	8,712

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.5.9 ICU beds by type of administration

Figure 38 shows the number of establishments with ICU beds as well as the actual number of ICU beds available in Krabi and Nakhon Si Thammarat province. Krabi province has only 2 establishments with hospital beds, one under Ministry of Public Health, and the other one being a private institution. Nakhon Si Thammarat province on the other hand has a total of 7 establishments with ICU beds, out of which 4 are under the Ministry of Public Health. In both provinces, the majority of ICU beds are under the Ministry of Public Health. In total, there are 18 and 71 ICU beds in Krabi and Nakhon Si Thammarat provinces, respectively.
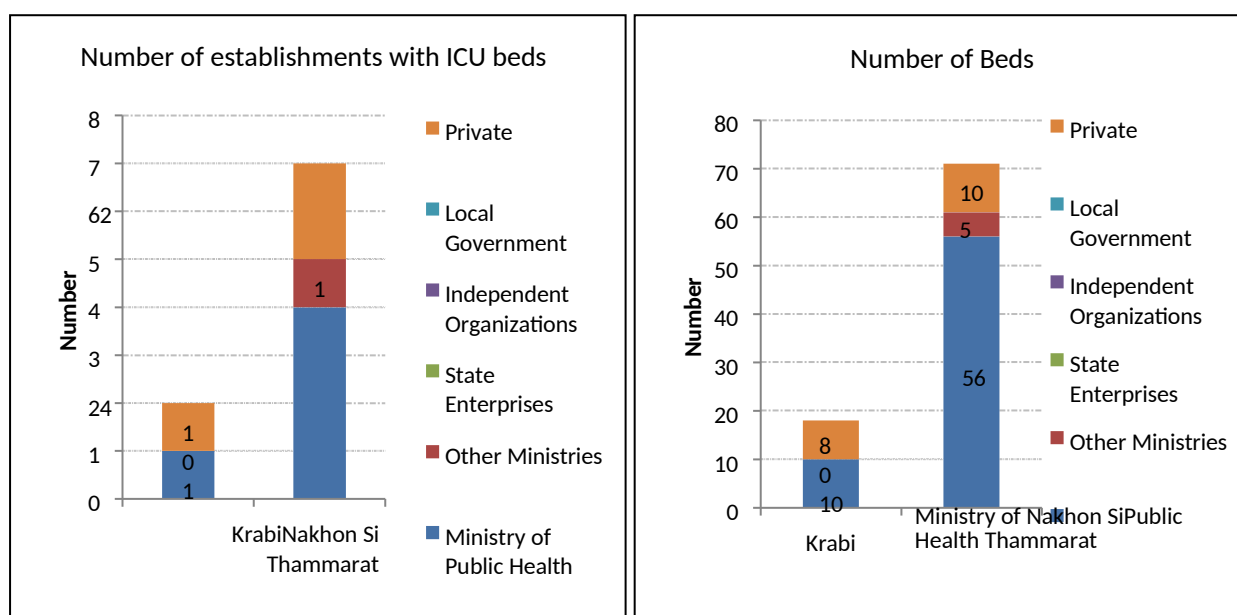
Figure 38: ICU beds by type of administration, 2017

Source: Report on public health resource in year 2017, Strategy and Planning Division, Office of the Permanent Secretary Ministry of Public Health, Ministry of Public Health, 2018

5.1.6 Public health emergency resources

This section discusses Thailand's state of preparedness in coping with disasters. Based on Thailand's National Disaster Prevention and Mitigation Plan for 2015, the Disaster Prevention and Mitigation Act of 2007 remains the main basis providing a framework for disaster risk management and mitigation in all sectors of the economy. The cabinet endorsed the current National Disaster Prevention and Mitigation Plan 2015 and enforced sectors of all levels to implement it, develop action plans at their level, and incorporate projects and programmes on disaster risk management into their annual planning processes.

5.1.6.1 Policy Framework

The National Disaster Prevention and Mitigation Plan 2015 plan's framework hinges on 4 key strategies for disaster mitigation and management. These include guidance on disaster risk reduction, integrated emergency management, effective recovery and resilience building, as well as strengthened international cooperation (Department of Disaster Prevention and Mitigation Ministry of Interior, 2015). At policy level, there is a National Disaster Prevention and Mitigation Committee (NDPMC) whose role is to develop a national policy framework for disaster prevention and mitigation and ensure the effectiveness of public and private cooperation and coordination in disaster risk management. Thailand has also adopted the Sendai Framework, which is a key global instrument for managing disasters from 2015 to 2030. Under this framework, the desired outcome is the substantial reduction of disaster risk and losses in lives, livelihoods, and health. Thailand's focus under this framework is on 4 key priorities. The first is to ensure that policies and practices for disaster risk management are based on an in-depth understanding of disaster risk in all its dimensions of vulnerability, capacity, and exposure of persons and assets, hazard characteristics and the environment. The second priority is to strengthen disaster risk governance to

better manage disaster risk at all levels. The third priority is to invest in disaster risk reduction for resilience. The fourth priority is to enhance disaster preparedness for effective response, recovery, rehabilitation and reconstruction (Department of Disaster Prevention and Mitigation Ministry of Interior, 2015).

5.1.6.2 Disaster preparedness plans and standard operational procedures

Less than half (43%) of the institutions in Thailand surveyed by Langkulsen and Rwodzi (2016) indicated that their plans for emergency preparedness and response were developed, including standard operational procedures. In Bangkok Metropolitan Administration (BMA) there are no drills or simulation exercises conducted to boost emergency preparedness (Langkulsen & Rwodzi, 2016). All hospitals on the other hand conduct drills and simulation exercises to test and strengthen emergency plans (Langkulsen, Rwodzi, Van der Putten, & Vajanapoom, 2018).

5.1.6.3 Community plan for mitigation, preparedness and response

All surveyed non-hospital institutions conduct risk and vulnerability assessments that reflect specific public health concerns. In addition, the institutions have in place preparedness and response plans that reflect the assessed risks to public health (Langkulsen & Rwodzi, 2016). A similar pattern has also been observed among the surveyed hospitals (Langkulsen et al., 2018).

5.1.6.4 community-based response and preparedness capacity

Training of staff in disaster response and preparedness is not happening at most institutions, except for those under Ministry of interior. BMA, for example, does not conduct any simulation exercises and drills based on preparedness plans (Langkulsen & Rwodzi, 2016). Although most of the surveyed hospitals do not conduct simulation exercises to boost their preparedness and response capacity, all of them conduct some training for community volunteers focusing on first aid as well as their role in public health interventions in emergencies (Langkulsen et al., 2018).

5.1.6.5 Local capacity of emergency provision of essential services and supplies

Except for institutions under the Ministry of Interior, institutions under other jurisdictions do not have enough capacity to provide essential emergency services and supplies. In Bangkok Metropolitan Administration, there was no plan listing the essential services and supplies needed to respond to emergencies (Langkulsen & Rwodzi, 2016). Almost all surveyed hospitals (92%) have community plans with detailed lists of essential commodities. In addition, transport and distribution arrangements are in place for the essential commodities (Langkulsen et al., 2018).

5.1.6.6 Advocacy and awareness

Most institutions in Thailand report that awareness materials on emergency preparedness and response are developed and disseminated widely to populations at risk. In addition, health systems related emergency preparedness and response

information is in place and made available across sectors in at least 75% of surveyed institutions (Langkulsen & Rwodzi, 2016). Similarly, majority (86%) of the surveyed hospitals indicated through education, information management, and communication, they conduct their advocacy and awareness to populations at risk (Langkulsen et al., 2018).

5.1.6.7 Risks and vulnerability assessment

Less than half (40%) of facilities under the Ministry of Public health of Thailand are provided with sufficient resources for conducting vulnerability assessments and risk mapping. On the other hand, just a third (33%) of facilities under the Local Administration ensure that their repository of information from vulnerability assessments include information specific to the health sector (Langkulsen & Rwodzi, 2016). Few hospitals (28%) had the knowledge, expertise and resources needed for conducting vulnerability assessments and risk mapping (Langkulsen et al., 2018).

5.1.6.8 Health facilities resilience

Coverage of institutions with emergency plans outlining emergency management, mass casualty management and evacuation procedures were high in Bangkok (79%). All facilities across Ministries, local administration and Bangkok Metropolitan Administration that risks in health facilities are assessed and prioritised, and that essential problems are mitigated (Langkulsen & Rwodzi, 2016).

5.1.6.9 Early warning and surveillance systems for public health

Across all 14 surveyed institutions in Bangkok, only 43% reported that they had functional response mechanisms that were integrated in disease surveillance systems from tambon to provincial levels. In addition, less than a third of the surveyed institutions (29%) indicated that knowledge of public health threats in emergencies was integrated in existing disease surveillance systems (Langkulsen & Rwodzi, 2016). Surveyed hospitals in Thailand do have advanced early warning and surveillance systems for identifying public health concerns. All 14 hospitals had surveillance and rapid response teams in place. However, majority of health staff (57%) at the surveyed hospitals were not trained in risk communication (Langkulsen et al., 2018).

5.1.6.10 Incident command system

The organizational structure of the country's incident command system identifies 3 sections namely operation, planning and support. The operation section is responsible for activities including transportation, firefighting, military resources, medical services and health care, search, and rescue efforts, as well as general security. The planning section handles emergency management and foreign affairs. The support section is the one responsible for ICT, public utilities and infrastructure, social welfare and human security, agriculture, energy, recovery of economic, education and cultural asserts, natural resources and environmental issues, as well as budgeting and handling donations (Langkulsen & Rwodzi, 2016). All hospitals primarily use electronic systems to complete their tasks, and use a variety of electronic communication modalities in exchanging information with others (Langkulsen et al., 2018).

5.1.7 Knowledge and information gaps

5.1.7.1 Review of lessons learnt

Many countries have suffered natural disasters in the past and continue to do so. Lessons can be learnt from disaster management case studies of different countries and be applied in similar circumstances. A systematic review of "Lessons learned" from operations in other countries, conducted by the National Institute for Emergency Medicine (2015) is helpful in developing the much-needed knowledge and providing clarity of direction to develop emergency medical system as part of disaster management in Thailand. This review examined the pattern of emergency management systems (EMS) in disaster situations among 8 countries, including United States, France, Canada, UK, Japan, People's Republic of China, Taiwan, and Indonesia. Summarised below are some of the key findings, according to the WHO conceptual framework for strengthening health system capacity for crisis management, from the review:

a. Leadership and Governance

Every country included in the review had a law specifically addressing disaster management. Though each country tries to address all phases of the disaster cycle, it is important to note that different countries have different policies for disaster preparedness and response. As a best practice for disaster management, each country needs a strategic plan on disaster management, which includes plan for delivery of emergency medical services.

b. Health Workforce

Most of the developed countries, e.g., US, Canada, and France, have a curriculum of training and education specific for Paramedics. However, the licensing systems for paramedics differ by country, and there is no paramedic license in some countries e.g., Indonesia, so they may give a nursing license for emergency responders with medical skills. Few countries have emergency physicians and nurses to provide onsite emergency medical services. Emergency Dispatchers are also an important group, particularly when it comes to communicating with the affected population and inter- agency collaboration.

c. Medical Equipment

The ideal situation in disaster preparedness and response is to have a stockpile system of supplies that can be delivered immediately to disaster areas. Storage of medical equipment can be decentralized to regional level. Developed countries are devising special systems for regional up-keep of medical equipment as well as emergency vehicles to support the work.

d. Health information

Before, during and after a disaster, relevant authorities should have access to information all the time. To be readily available is health information related to risk assessment, risk communication with the public and an emergency medical personnel

database system. Health information systems in other countries can be shared via the internet or specialized networks.

e. Health Financing

Fiscal management of health care and services differ from country to country. In some countries funds are allocated as block grants. In Indonesia, fiscal budget can be distributed through the implementation of a strategic plan. In other countries, emergency medical services are decentralized by providing budget allocations to the local governments.

f. Service Delivery

Delivery of health services also differ from country to country because of differences in disaster phases for each country, as well as the health needs of population. Prior to a disaster, health services needed should focus on practice and training not only for emergency medical service staff, but also for the generality of the population at risk. Other agencies provide information regarding safety, survival skills and service delivery during disaster. The common general purpose for emergency medical care during a disaster is to stabilize the victims before transferring them to the hospital, moving victim, and assisting medical personnel in the affected area.

5.1.7.2 Policy Choices at a Country Level for Thailand:

Based on the review, three approaches have been identified to classify the policy choices for improving the emergency medical service system for disaster management in Thailand (National Institute for Emergency Medicine, 2015).

a. Decentralization of disaster administration

This model assumes that one system cannot fit all the situations around the country, so responsibility should put on local or regional administrative bodies. In this case the local government can prepare themselves appropriately within the context of their geographic area. The strength of the model is that decisions are made by local governments themselves, hence decisions can be made much faster. However, the model may result in lack of linkages between the central government and local governments in the control or standardization of management. Therefore, efficient and timely systems of national communication would need to be developed to support the implementation of this model.

b. Centralization of disaster administration

This model implies a consistent design by the government and can integrate services used between public agencies in natural disaster situation. In this case, central government is the decision maker and coordinates activities of other agencies according to a disaster relief plan. The executive allocates the budget and support under the assumption that the whole country is acting as one system to respond to the disaster. The advantage is that the response will be more powerful, and coordination of services will be facilitated under a single command structure. The challenge in this

case, however, is on integrating and improving the participation and awareness of local communities to respond to medical emergencies during disasters.

c. Multisectoral management

Multisectoral management refers to deliberate collaboration among various stakeholder groups, including government, civil society, and private sector. Multisectoral coordination refers to deliberate collaboration between stakeholders towards the shared goal and enhanced emergency preparedness and health security (WHO, 2020). The strength of this model is that it strengthens Public – Private Partnership. For it to be successful, a country must develop/design the collaborations between agencies in the planning and implementation of emergency medical services prior to disaster situations. In the UK, the emergency health care was managed by the public and private organizations in terms of the Ambulance Trust that provided the training system for the health management planners in response to disaster situations.

In Thailand, the multisectoral action for health requires engagement across organizational boundaries, including government, citizens, and private sector. However, the capacity building is needed at individual, institutional, and system levels (Tangcharoensathien et al., 2017).

5.2 Economic dimension

Hydrometeorological disasters in both Krabi and Nakhon Si Thammarat provinces threaten the livelihoods and economic activities for people residing in those areas. The economic dimension provides a mapping of the livelihoods and areas of economic activity that are prone to the direct and indirect follow-on effects of hydrometeorological disasters. Under the economic dimension, parameters such as designation of tracks of land for nature and landscape conservation, cultural heritage, settlement types, and transport networks were mapped as these are the main facets of economic activity and livelihoods to be affected by hydrometeorological disasters.

5.2.1 Conservation designation

Data on conservation designation was collated from the development plans of Krabi and Nakhon Si Thammarat provincial offices and is summarized below.

5.2.1.1 Development Plan for Krabi, year 2018-2022

1. **Forest Resources**
   1.1 National Reserved Forest
      a) 45 national reserved forests
      b) Area of 226,552.32 hectares (1,415,952 rai) that area was given to Agricultural Land Reform Office 89,700.32 hectares (560,627 rai) and the remaining total area of national reserved forests were 136,852 hectares (855,325 rai).
   1.2 National Park
      a) 4 national parks (Khao Phanom Bencha National Park, Hat Noppharat Thara–Mu Ko Phi Phi National Park, Mu Ko Lanta National Park, Than Bokkhorani National Park)

b) Area of 67,601.92 hectares (422,512 rai)

1.3 Wildlife Sanctuary

a) 2 wildlife sanctuaries (Klong Praya Wildlife Sanctuary, Khao Pra – Bang Kram Wildlife Sanctuary)

b) Area of 31,038.08 hectares (193,988 rai) that area is in Krabi province 22,430.08 hectares (140,188 rai).

1.4 Non-Hunting Area

a) 1 non-hunting area (Thung Thale Non-Hunting Area) in Ko Klang Sub-district, Ko Lanta District

b) Area of 4,901.28 hectares (30,633 rai)

1.5 Mangrove Forest Area

a) 5 districts (Amphoe Mueang Krabi, Amphoe Ao Luek, Amphoe Nuea Khlong, Amphoe Khlong Thom, Amphoe Ko Lanta)

b) Area of 35,504 hectares (221,900 rai)

2. Marine and Coastal Resources

2.1 Coral

a) There are approximately 13.53 km^2 of coral reefs along the coastline of the Andaman Sea and small islands. The coral reefs were rated fair.

b) These coral reefs are in Hat Noppharat Thara–Mu Ko Phi Phi National Park and Mu Ko Lanta National Park.

2.2 Seagrass

a) Seagrass along the coasts in Amphoe Mueang Krabi (Ban Tha Lane, Ban Tao Than, Ban Khao Thong Tai, Ban Lum Than, Ao Nang) and Amphoe Nuea Khlong (Ko Jum, Ko Sriboya, Ko Lang, Ko Tor)

b) 8 species of seagrass include Halophila ovalis

2.3 Marine Endangered Species

a) Dolphin and whale in Andaman Sea near Mu Ko Phi Phi

b) Dugong in Ko Sriboya and Ko Jum

2.4 Biodiversity

a) Wetland areas at Krabi River Estuary Ramsar Site Conservation (1,100[th] in the world) and mangrove forest cover area of 102.12 km^2. Mangrove forest in Krabi River Estuary has red mangrove and cover 31% of total mangrove forest in Krabi (5% of Thailand). In Krabi River Estuary, there are aquatic animals and at least 50 species of economic fishes.

b) Muddy beach cover area of 12 km. Muddy beach between Krabi River Estuary and Khlong Yuan approximately 930 hectares (5,812.5 rai). Muddy beach at Krabi River Estuary is the important for migratory birds and their habitats of Thailand. Some bird species is listed as near threatened.

c) 107 migratory bird species, 139 shorebird species, 137 resident bird species in Ko Sriboya

d) 90% of seagrass species in Thailand

5.2.1.2 Development Plan for Nakhon Si Thammarat, year 2018-2022

1. Forest Resources
1.1 National Park
- a) Khao Luang National Park 57,000 hectares (356,250 rai)
- b) Numtok Yong National Park 20,500 hectares (128,125 rai)
- c) Khao Nan National Park hectares 40,979.36 (256,121 rai)
- d) Si Khit Waterfall National Park 14,500 hectares (90,625 rai) in Nakhon Si Thammarat province and Suratthani province
- e) Hat Khanom – Mu Ko Thale Tai National Park 31,500 hectares (196,875 rai) that preparing for announcement
- f) Khao Pu – Khao Ya National Park (Partial) 9,180 hectares (57,375 rai) in Nakhon Si Thammarat province and Phatthalung province

1.2 National Reserved Forest
- a) 69 national reserved forests
- b) 139,643.23 hectares (872,770.20 rai)

1.3 Non – Hunting Area
- a) Laem Talumphuk Non – Hunting Area 5,672.96 hectares (35,456 rai)
- b) Bo Lo Non – Hunting Area 10,015.84 hectares (62,599 rai)

1.4 Wildlife Sanctuary Area
- a) Ka Toon Wildlife Sanctuary Area 10,048 hectares (62,800 rai)

1.5 Wildlife Conservation Development and Extension Station
- a) NaKhon Si Thammarat Nature and Wildlife Education Center 1,122.88 hectares (7,018 rai)

2. Mangrove Forest 23,938.65 hectares (149,616.57 rai)
2.1 Mangrove forest remained unchanged 12,947.59 hectares (80,922.46 rai)

2.2 Mangrove forests are altered 10,991.06 hectares (68,694.11 rai)

5.2.2 Settlement type

5.2.2.1 Housing characteristics

In both provinces, the proportion of households residing in non-permanent materials dwellings has been declining since 2010. During the same period, the proportion of households with proper sanitation has been on an upward trend (Figure 39).
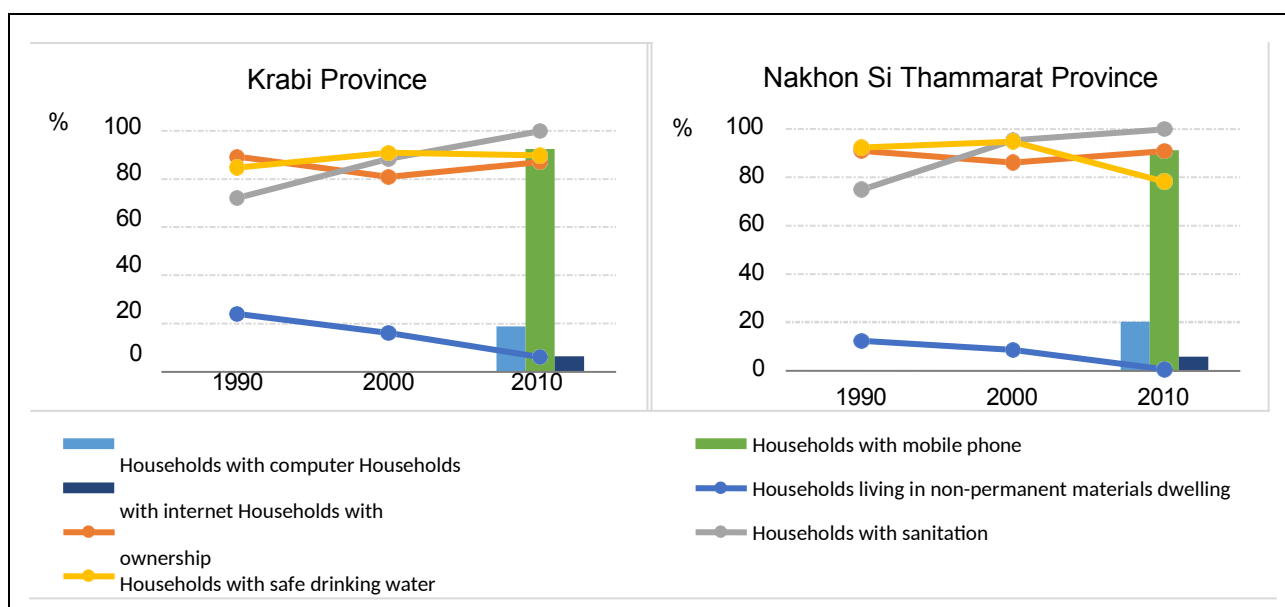
Figure 39: Housing characteristics in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.2.2 Migration patterns

The proportion of people who were not living in their province of birth followed a similar pattern in the two provinces, reaching a peak in 2000 and then coming down again in 2010 (Figure 40).
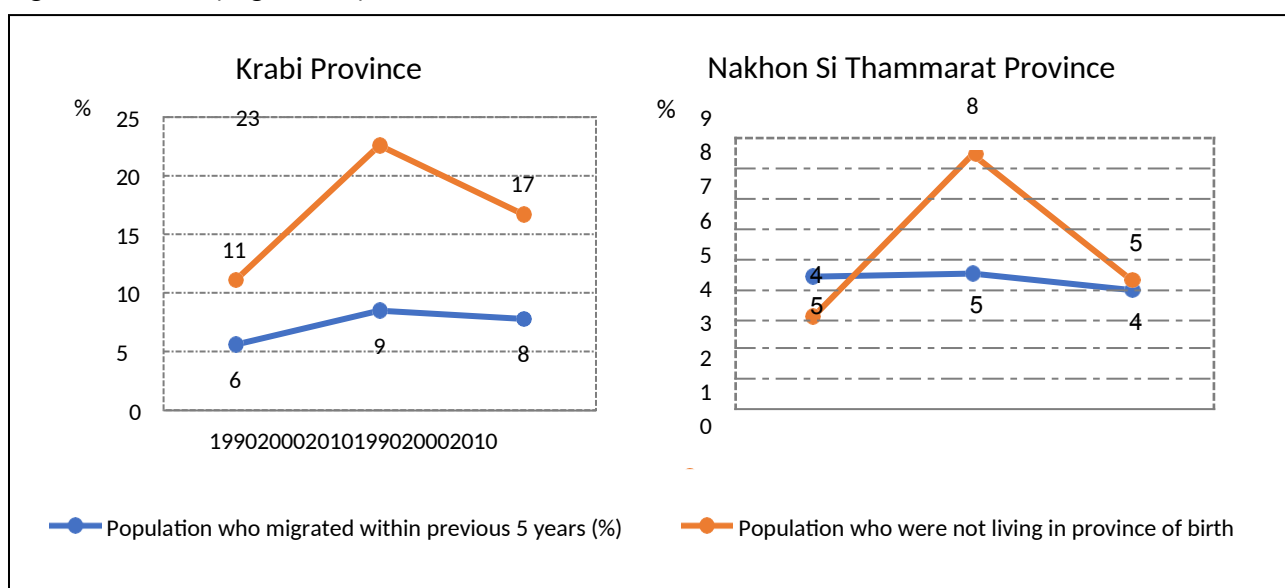
Figure 40: Migration patterns in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.2.3 Household Characteristics

As shown in Figure 41, average household size is declining in both Krabi and Nakhon Si Thammarat provinces. Since 1990, the proportion of female headed households, and one-person households is increasing.
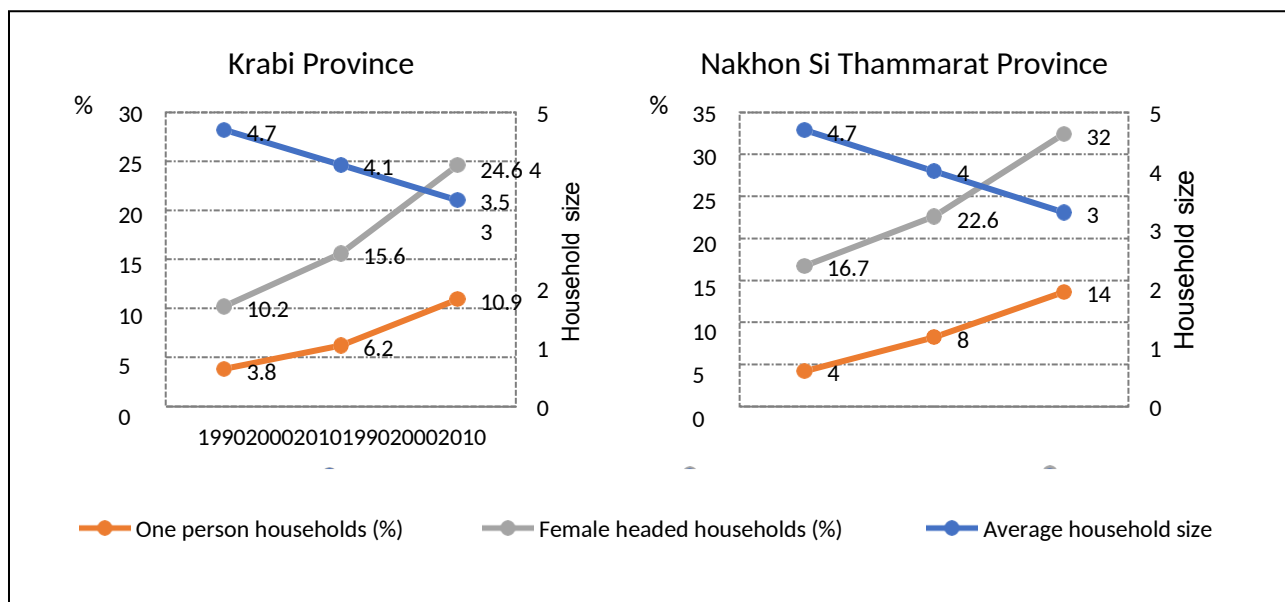
Figure 41: Household characteristics in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.2.4 Types of living quarters

The majority of living quarters in Krabi and Nakhon Si Thammarat provinces are detached houses, and most of these are found in the non-municipal areas compared to municipal areas (Figure 42).
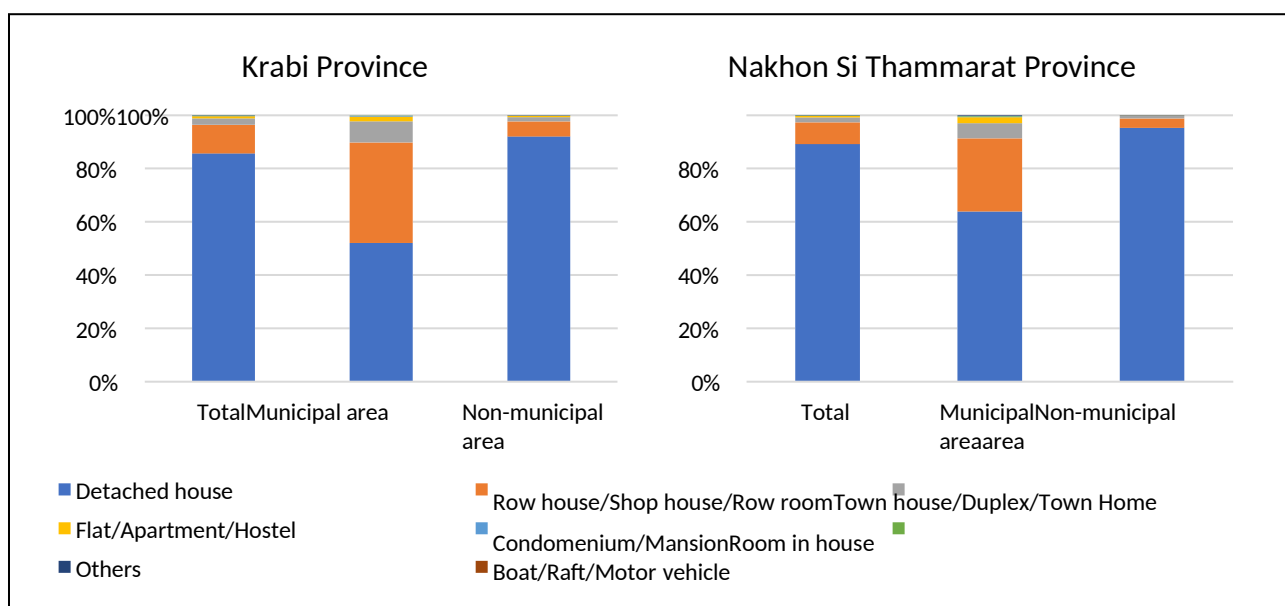
Figure 42: Types of living quarters in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.2.5 Tenure of living quarters

The majority of living quarters in both provinces are fully owned, as owners are no longer paying any instalments. In the municipal areas, a considerable proportion of living quarters are either rented, or instalments are still being paid (Figure 43).
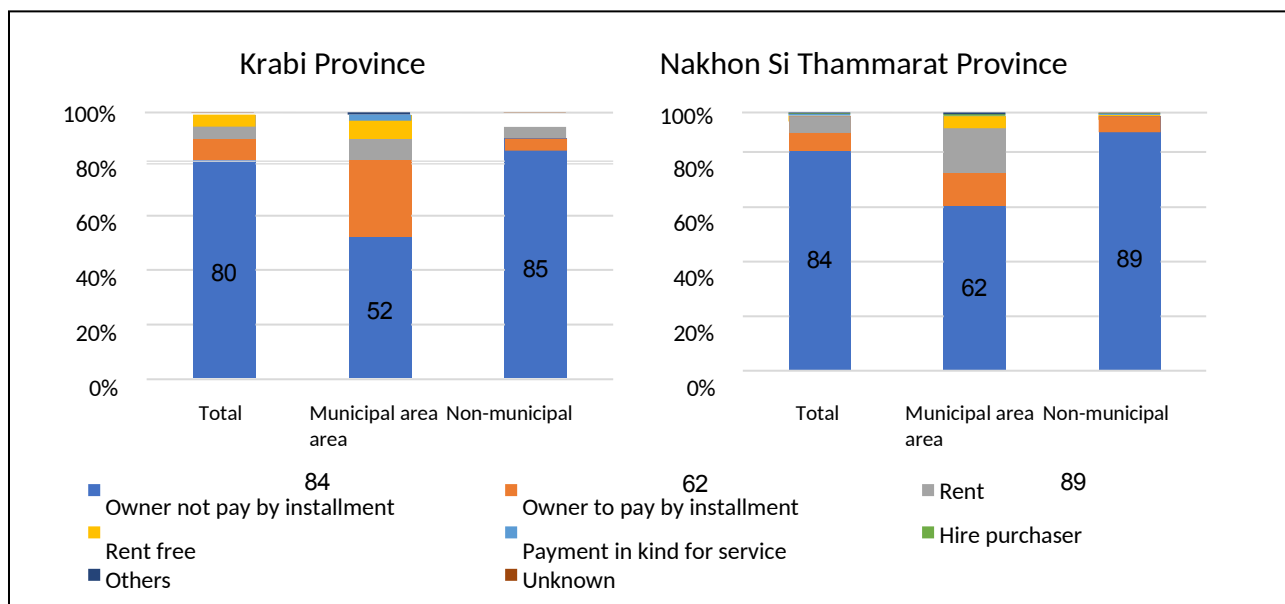
Figure 43: Tenure of living quarters in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.2.6 Construction materials

As shown in Figure 44, most living quarters in both municipal and non-municipal areas are constructed using cement or brick. Very few are constructed using non-permanent or reusable materials.
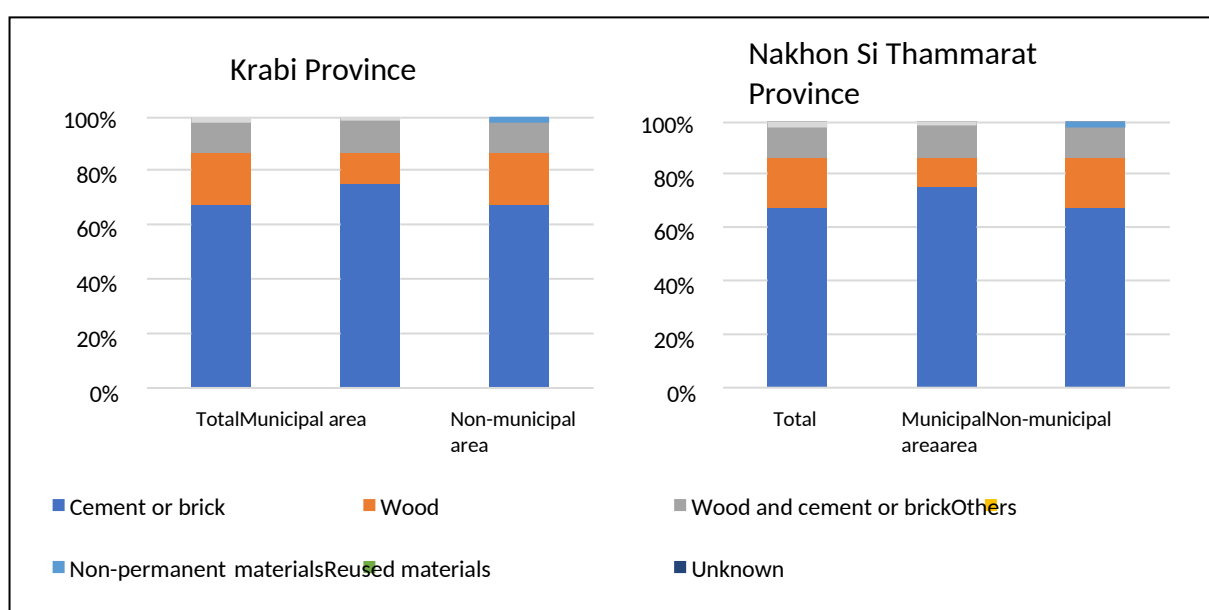
Figure 44: Construction materials used in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.3.7 Land ownership

In both Krabi and Nakhon Si Thammarat provinces, more than 80% of the land in both municipal and non-municipal areas is fully owned (Figure 45).
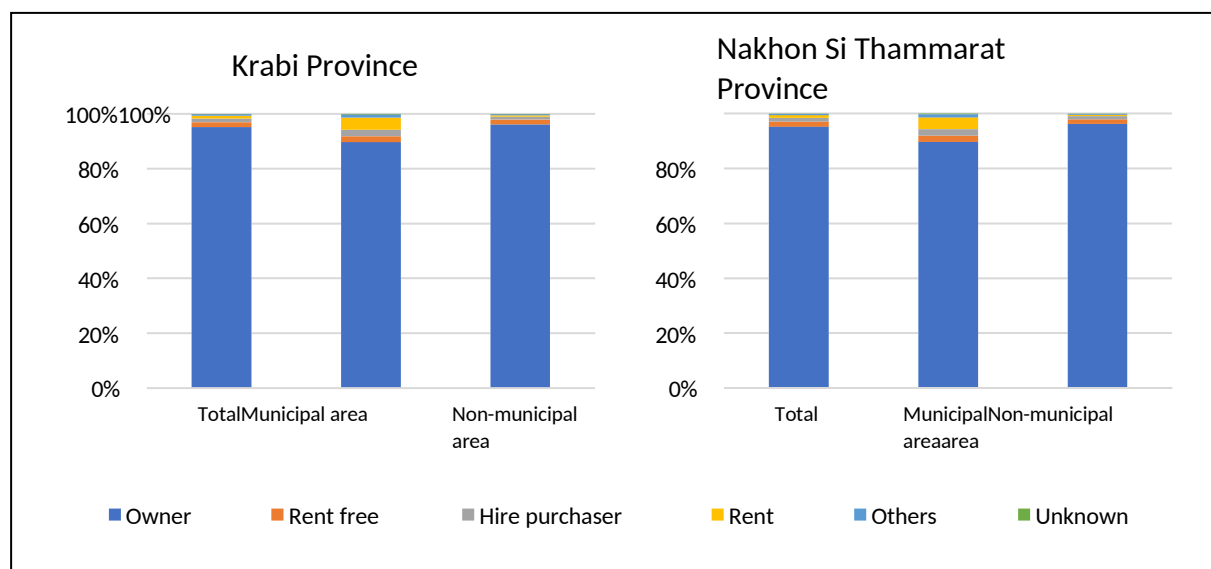
Figure 45: Land ownership in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.2.7 Household size

As shown in Figure 46, more than 60% of households in the municipal areas have at most 3 members compared to under 60% in non-municipal areas. This pattern is similar in both Krabi and Nakhon Si Thammarat provinces.
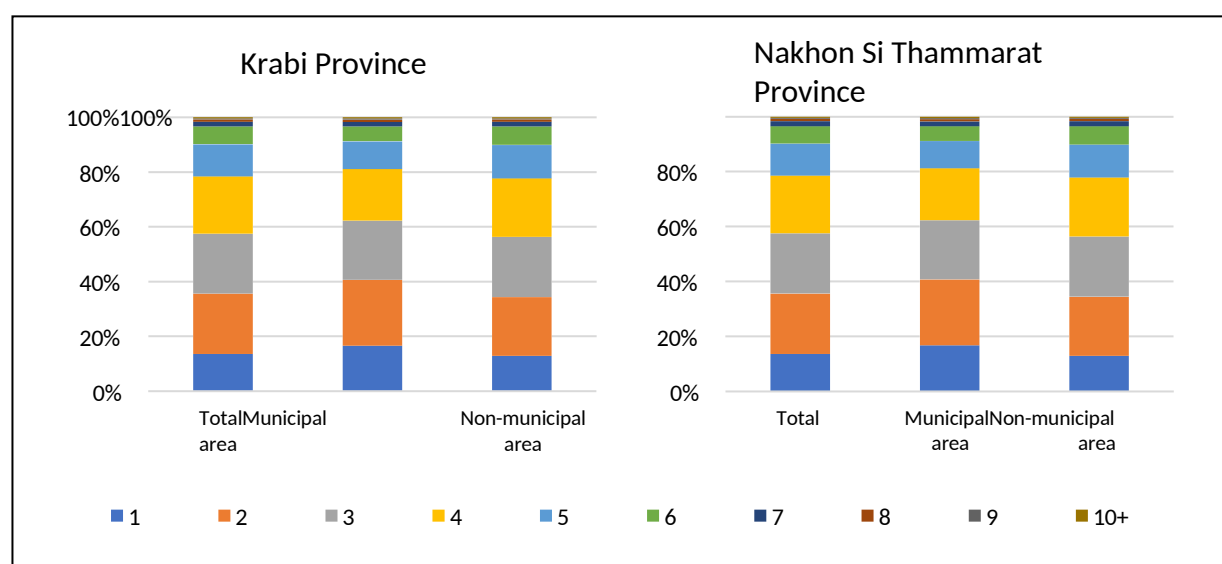
Figure 46: Household sizes in Krabi and Nakhon Si Thammarat provinces
Source: National Statistical Office, 2012

5.2.3 Transport links

The means of transportation from Bangkok to either Nakhon Si Thammarat or Krabi province are varied, and include highways, railways, and air.

5.2.3.1 Air transportation

Both Nakhon Si Thammarat and Krabi provinces have international standard airports under controlling of department of commercial air transport. Thai Airways International, Thailand's national airline, operates a daily round trip flights to Nakhon Si Thammarat. Various airlines including Nok Air, Thai Air Asia, Thai Lion Air among others also operate flights from Bangkok to Krabi International Airport.

5.2.3.2 Rail transportation

The State railway of Thailand has an efficient rail system linking Bangkok and Nakhon Si Thammarat with 2 express trains. The distance from Bangkok to Nakhon Si Thammarat province by train is approximately 832 km. There are also domestic trains comprising first, second and third-class carriages, and 3 suburb trains go to nearby provinces. There are no direct train services from Bangkok to Krabi. Travellers by train must get off at Thung Song Train Station (in Nakhon Si Thammarat) or Trang Train Station, and then proceed by road to Krabi.

5.2.3.3 Road transportation

Nakhon Si Thammarat province has 1 main highway, 5-sub highway, and 43 provincial roads. Domestic bus service offers fast means of travel from Nakhon Si Thammarat to Bangkok with about 6 bus companies. Vans, taxis and public buses offer transport services to nearby provinces. As for Krabi, a daily bus service is available from the Bangkok Southern Bus Terminal on Borommaratchachonnani Road, and the journey takes 12-13 hours. To travel from Bangkok to Krabi provinces by car, there is a choice between two routes. The first is to take Highway No. 4 (Phetchakasem Road), passing Phetchaburi–Prachuap Khiri Khan–Chumphon–Ranong–Phang-nga, to Krabi. The total distance is 946 km. The second option is to take Highway No. 4 (Phetchakasem Road), and connecting to Highway No. 41 via Amphoe Lang Suan, Chumphon and Amphoe Chaiya, Surat Thani. This total distance with this route is 814 km.

5.2.3.4 Sea transportation

There are no regular ship or cruise connections between Bangkok and either Nakhon Si Thammarat or Krabi province. Three local seaports use to transport cargo and fishery.

5.3 Socio-economic impact assessment

The social and economic dimensions were combined to produce socio-economic resilience index maps. The resilience to hydrometeorological hazards was considered a function of exposure, vulnerability, and coping capacity. Population density at subdistrict level was the exposure variable used and was measured on a scale from 0 to 5, with 5 representing the highest level of exposure (see section 5.3.2). Several variables were considered under the dimension on vulnerability, including proportion of infants, proportion of children under the age of five, proportion of population aged 60 years and over, number of prisoners, number of orphans and homeless people, number of disabled persons, proportion of population with chronic diseases, and area of mangrove forest, and the same scale from 0 to 5 was applied, with 5 representing greatest level of vulnerability. Resilience is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UNDRR, 2022). Combining the exposure and vulnerability variables, we derived socio-economic resilience index scores from 0 to 45, with lower scores representing greater resilience. A detailed explanation of the method used is provided in Section 5.3.2.

Coping capacity is the ability of people, organisations, and systems, using available skills and resources, to manage adverse conditions, risk or disasters. The capacity to cope requires continuing awareness, resources, and good management, both in normal times as well as during disasters or adverse conditions. Coping capacities contribute to the reduction of disaster risks (UNDRR, 2022). In this report, coping capacity refers to the availability of skills (soft coping capacities) and structural resources (hard coping capacities) to help communities manage and respond to hydrometeorological hazards. Based on there being readily available data, the only variable considered under soft coping capacity was literacy rate, and this was measured on a scale from 0 to 1, with 1 representing that an area had a literacy rate greater or equal to 90%. A community's capacity to cope requires continuing awareness amongst the population, hence the inclusion of literacy rate. For the hard coping capacities, the study took into consideration the availability of a hospital at subdistrict, district/provincial levels as well as telecommunication development. Combining the soft and hard coping capacities, the study then derived and mapped the coping capacity index scores ranging from 0 to 4, with 4 representing the maximum possible coping capacity. A detailed explanation of the method used is provided in Section 5.3.2.

5.3.1 Socio-economic resilience index

As of 2017, Krabi province had a total population of almost 500,000. Mueang Krabi was the most densely populated, with the least populated being Ko Lanta district (Figure **47**).
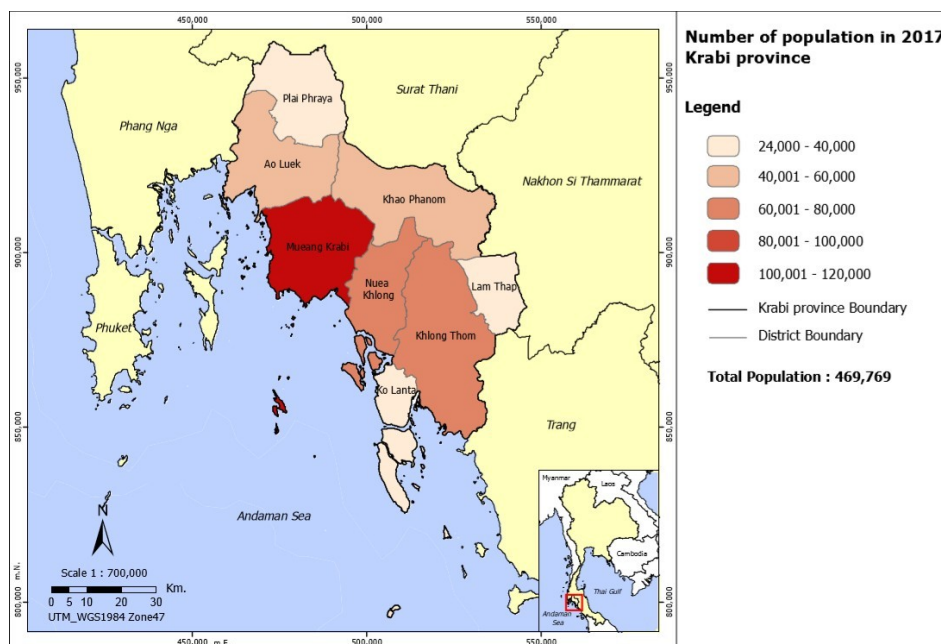
Figure 47: Population in Krabi province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

In 2017, Nakhon Si Thammarat province had a total population of more than 1.5 million people. Muang Nakhon Si Thammarat was the most densely populated district, followed by Thung Song district (
Figure **48**).
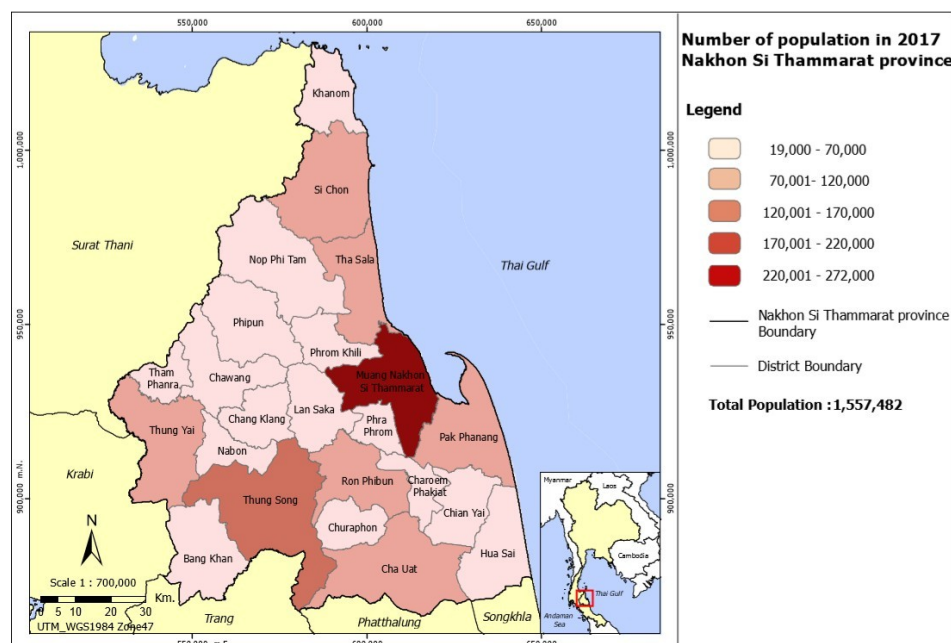
Figure 48: Population in Nakhon Si Thammarat province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

A sex ratio of 1:1 was observed in 3 districts namely Ao Luek, Khao Phanom and Lam Thap. In 2 districts, Mueang Krabi and Nuea Khlong, there were more males than females; and in the remaining 3 districts (Plai Phraya, Khlong Thom and Ko Lanta) there were more females than males (Figure 49).
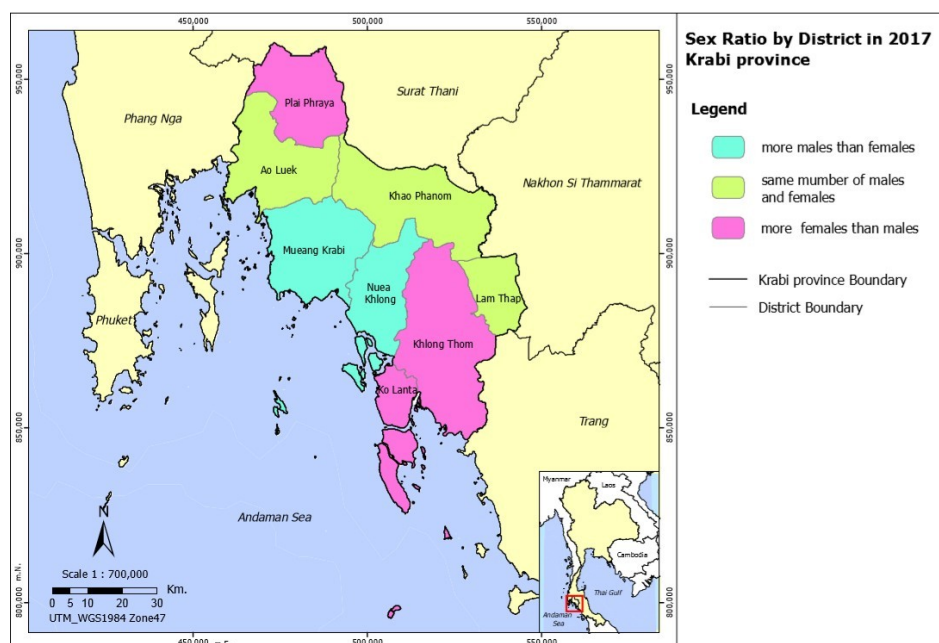
Figure 49: Sex ratio by district in Krabi province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

In most of the districts in Nakhon Si Thammarat province, there were more males than females. Only one district, Bang Khan, had more females than males (Figure 50).
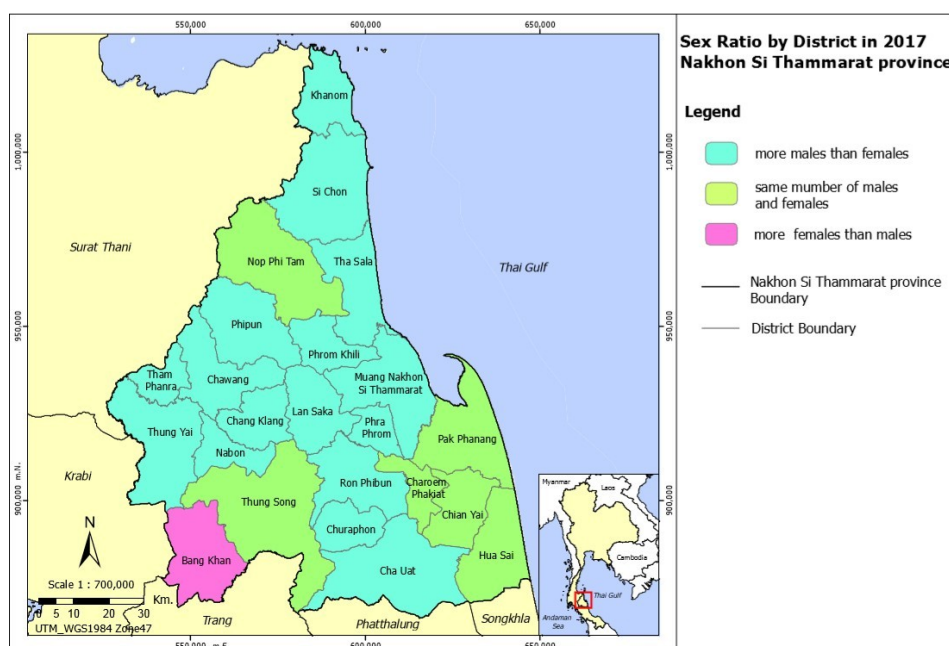
Figure 50: Sex ratio by district in Nakhon Si Thammarat province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

The total province had over 180,000 households as of 2017. As with the total population, Mueang Krabi also had the highest number of households (
Figure 51).
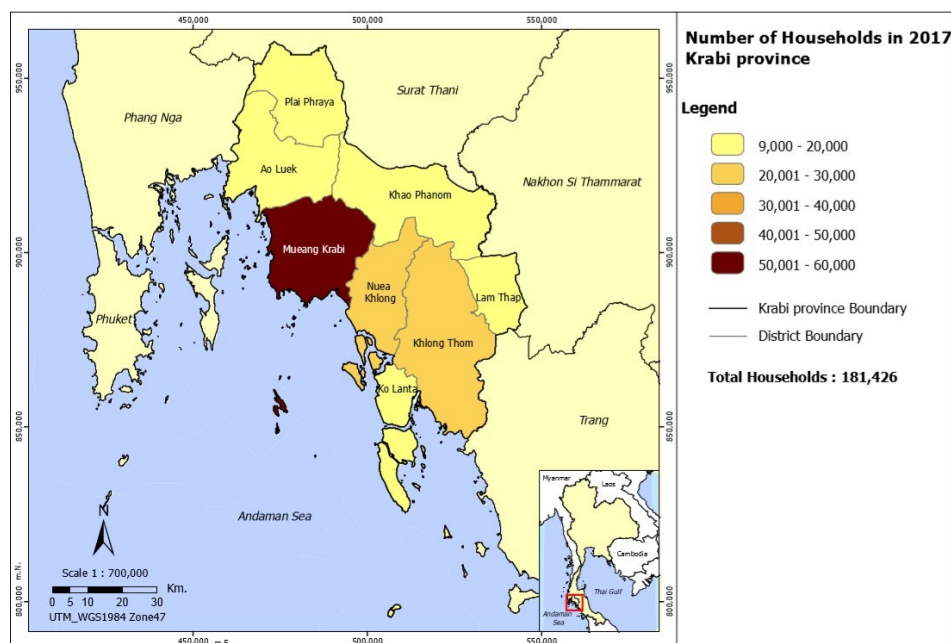
Figure 51: Number of households in Krabi province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

The total province had over half a million households as of 2017. As with the total population, Mueang Nakhon Si Thammarat also had the highest number of households (
Figure 52).
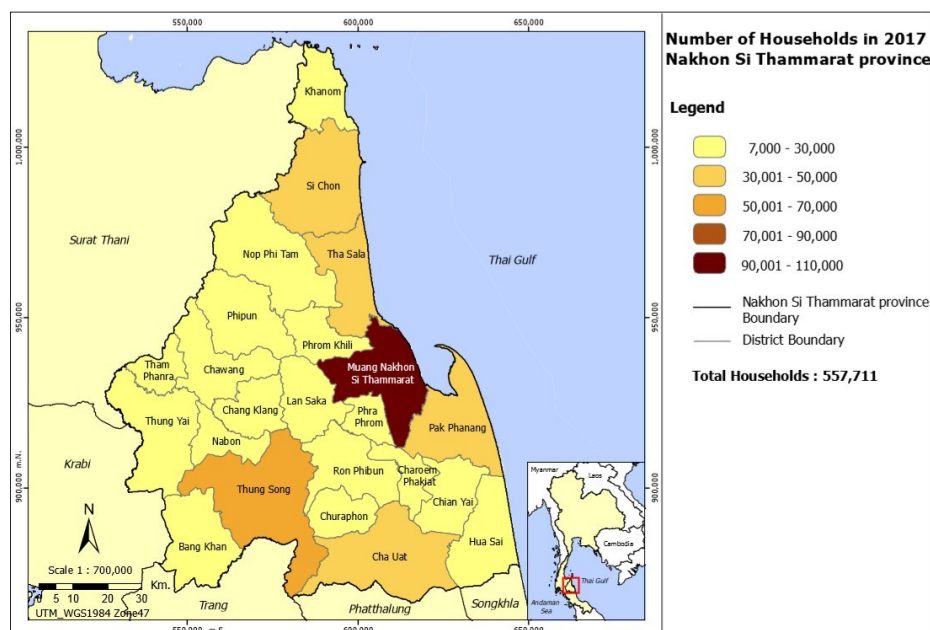
As of 2017, Ko Lanta district had the highest proportion of children under 14 years. Two districts (Plai Phraya and Khao Phanom) had the highest proportions of the economically active group aged 15-59 years. Of particular interest is Plai Phraya in that the district had not only the highest proportion of the economically active age group, but also had one of the highest proportions of the elderly. Ao Luek and Nuea Khlong are the other 2 districts with the highest proportions of the elderly (Figure 53).
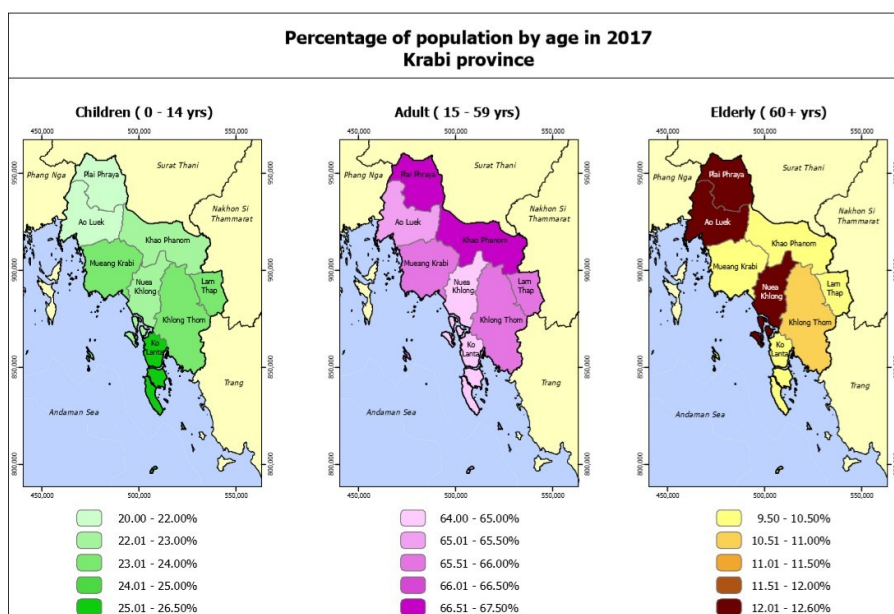
Figure 53: Population distribution by age, Krabi province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

As of 2017, Bank Khan district had the highest proportion of children under 14 years while Nop Phi Tam district had the highest proportion of the economically active group aged 15-59 years. Three districts (Pak Phanang, Chian Yai and Hua Sai) had the highest proportions of the elderly age group (Figure 54).
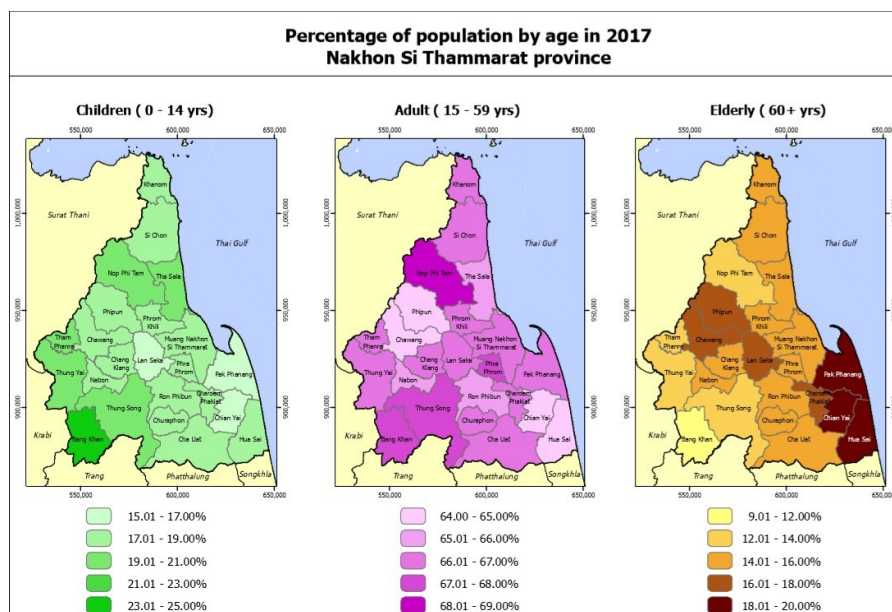
Figure 54: Population distribution by age, Nakhon Si Thammarat province, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

5.3.2 Socio-economic resilience

The resilience to water-related disasters index is one of the five key dimensions (KDs) of water security that describes the capacity of a country to cope with and recover from the impacts of water-related disasters (Asian Development Bank, 2016). Ninety percent of recorded major disasters (1995-2015) caused by natural hazards linked to climate and weather including floods, storms, heat waves, and droughts. Four priority areas for action to reduce losses due to climate-related events are the following:

1) Understanding disaster risk;
2) Strengthening disaster risk governance to manage disaster risk;
3) Investing in disaster risk reduction for resilience;
4) Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction (UNDRR, 2015).

Resilience as defined by the Sendai Framework is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UNISDR, 2017). Mapping resilience in urban areas poses a challenge as there are no agreed-on methodological approaches for doing so (Cariolet, Vuillet, & Diab, 2019). The choice of variables and indicators to measure and map resilience is often a function of data availability and reliability. In addition, indicators developed in one specific context may not be applied systematically to other contexts as resilience is a context-dependent concept (Cariolet et al., 2019).

Siebeneck, Arlikatti, and Andrew (2015) used the Disaster Resilience of Place (DROP) model to examine disaster resilience at the provincial level in Thailand. Results of the model suggest that while disaster resilience is generally higher in the more urbanized areas, communities located in rural areas in Thailand may not

necessarily be less resilient to the impacts of disasters. As such, the role of place in disaster resilience

needs to be considered in any resilience model, as indicators need to capture the unique cultural and structural characteristics of the study area.

The resilience to water-related disasters index is based on processing of data on exposure, vulnerability, and coping capacity as shown in Table 14. Coping capacity refer to the ability of people, organizations and systems to manage risks using available skills and resources (UNISDR, 2017). Coping capacity was categorized into two, i.e., soft coping capacity and hard coping capacity, which were derived from variables that assess the community capacity for coping with disasters. Soft coping capacities entail the personal qualities that enable people to better manage risks. Literacy was the only measure of soft coping capacities included in this analysis. Hard coping capacities, on the other hand, include the available physical resources that people can rely on as they manage risks and disaster situations.

Table 14: Variables used to measure disaster resilience

Sub-indicators	Variables	Definition[1]	Data Sources[2]	Year of Data
Exposure	Population density	Population density (scale 0 to 5) • 0 = 0 • 1 = 1-200 people per square kilometer • 2 = 201-400 people per square kilometer • 3 = 401-600 people per square kilometer • 4 601-800 people per square kilometer • 5 > 800 people per square kilometer	DOPA	2017
Vulnerability	Percentage of infant	Percentage of infant (scale 0 to 5) • 0 = 0% • 1 = 0.1%-0.4% • 2 = 0.5%-0.8% • 3 = 0.9%-1.2% • 4 = 1.3%-1.7% • 5 > 1.7%	DOPA	2017
	Percentage of children under the age of five	Percentage of children under the age of five (scale 0 to 5) • 0 = 0% • 1 = 0.1%-2.5% • 2 = 2.6%-5.0% • 3 = 5.1%-7.5% • 4 = 7.6%-10.0% • 5 > 10.0%	DOPA	2017
	Percentage of elderly population (60+)	Percentage of elderly population (60+) (scale 0 to 5)	DOPA	2017

Sub-indicators	Variables	Definition[1]	Data Sources[2]	Year of Data
		• 0 = 0% • 1 = 0.1%-5.0% • 2 = 5.1%-10.0% • 3 = 10.1%-15.0% • 4 = 15.1%-20.0% • 5 > 20.0%		
	Number of prisoners	Number of prisoners that exposed or at risk from disasters (scale 0 to 5) • 0 = 0 • 1 = 1-1,000 prisoners • 2 = 1,001-2,000 prisoners • 3 = 2,001-3,000 prisoners • 4 = 3,001-4,000 prisoners • 5 > 4,000 prisoners	DOC	2018
	Number of orphans and homeless persons	Number of orphans and homeless persons that exposed or at risk from disasters (scale 0 to 5) • 0 = 0 • 1 = 1-100 persons • 2 = 101-200 persons • 3 = 201-300 persons • 4 = 301-400 persons • 5 > 400 persons	DCY, DSDW, DJOP	2019
	Number of disabled persons	Number of disabled persons that exposed or at risk from disasters (scale 0 to 5) • 0 = 0 • 1 = 1-250 persons • 2 = 251-500 persons • 3 = 501-750 persons • 4 = 751-1,000 persons • 5 > 1,000 persons	DSDW, Krabi Provincial PHO, Nakhon Si Thammarat Provincial PHO	2019
	Prevalence of chronic diseases	Prevalence of chronic diseases include CKD, COPD, DM, HT, DM+HT, stroke (scale 0 to 5) • 0 = 0 • 1 = total disease prevalence 0.1-3.5 • 2 = total disease prevalence 3.6-7.0 • 3 = total disease prevalence 7.1-10.5 • 4 = total disease prevalence 10.6-14.0 • 5 = total disease prevalence > 14.0	Krabi Provincial PHO, Nakhon Si Thammarat Provincial PHO	2019
	Total area of mangrove forest	Total area of mangrove forest (scale 0 to 5)	DMCR	2018

Sub-indicators	Variables	Definition[1]	Data Sources[2]	Year of Data
		• 0 = 0 rai • 1 = 1-3,000 rai • 2 = 3,001-6,000 rai • 3 = 6,001-9,000 rai • 4 = 9,001-12,000 rai • 5 > 12,000 rai		
Soft coping capacities	Literacy rate	Literacy rate (scale 0 to 1) • 0 < 90% • 1 $\geq$ 90%	NSO	2018
Hard coping capacities	Hospital at subdistrict level	Hospital at subdistrict level (scale 0 to 1) • 0 = No • 1 = Yes	Strategy and Planning Division, Office of the Permanent Secretary of MoPH	2019
	Hospital at district and provincial level	Hospital at district and provincial level (scale 0 to 1) • 0 = No • 1 = Yes	Strategy and Planning Division, Office of the Permanent Secretary of MoPH	2019
	Telecommunication development	Information and communication technology master plan at SAO and Municipality level (scale 0 to 1) • 0 = No • 1 = Yes	DLA, SAOs, Municipalities	2019

[1] CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; HT = hypertension; SAO = Subdistrict Administration Organization

[2] DOPA = Department of Provincial Administration, Ministry of Interior; DOC = Department of Corrections, Ministry of Justice; DCY = Department of Children and Youth, Ministry of Social Development and Human Security; DSDW = Department of Social Development and Welfare, Ministry of Social Development and Human Security; DJOP = Department of Juvenile Observation and Protection, Ministry of Justice; PHO = Public Health Office, Ministry of Public Health; DMCR = Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment; NSO = National Statistical Office; OBEC = Office of the Basic Education Commission, Ministry of Education; MoPH = Ministry of Public Health; DLA = Department of Local Administration, Ministry of Interior; SAOs
= Subdistrict Administration Organizations

5.3.2.1 Exposure

Exposure is defined as the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas (UNDRR, 2022). This study has considered population density as a measure of exposure to hydrometeorological hazards. As of 2017, most of the districts in both Krabi and Nakhon Si Thammarat had a population density of 1 to 200 persons per square kilometre with the highest population densities associated with urban areas located mostly on or close to the coast (Figure 55).
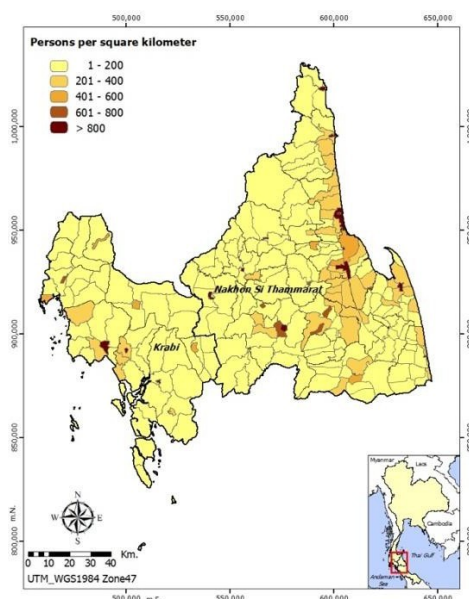
Figure 55: Population density per km2 in Krabi and Nakhon Si Thammarat Provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

5.3.2.2 Vulnerability

Vulnerability is a measure of the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards (UNDRR, 2022). While majority of districts in Nakhon Si Thammarat province had an infant population ranging from 0.9% to 1.2%, most districts in Krabi province had a higher proportion of infants, ranging from 1.3% to 1.7% (Figure 56).
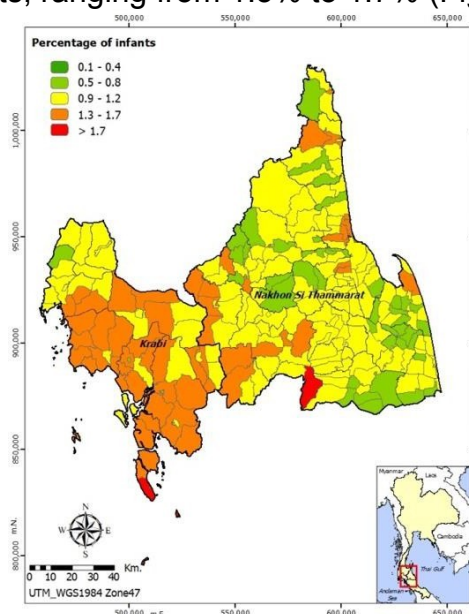
Figure 56: Proportion of infants in Krabi and Nakhon Si Thammarat Provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

Most districts in Krabi province had a higher proportion of children under-five years of age compared to Nakhon Si Thammarat province. For Nakhon Si Thammarat province, districts closer to the border with Krabi province exhibited a similar pattern (Figure 57).
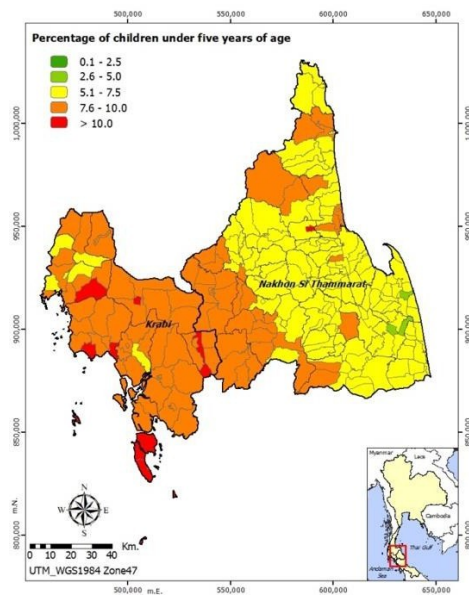
Figure 57: Proportion of children under the age of five in Krabi
and Nakhon Si Thamarat provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

Overall, most districts in Nakhon Si Thammarat had a greater proportion of population aged 60 years and over, ranging from 15.1% to greater than 20% (Figure 58).
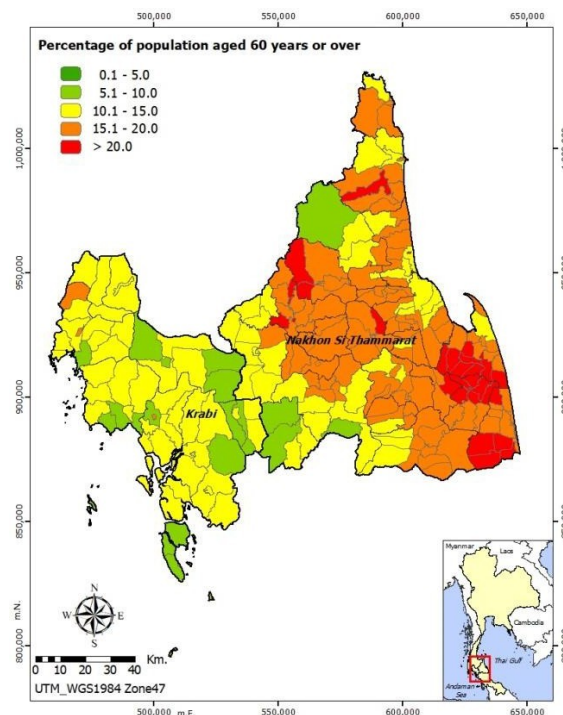
Figure 58: Proportion of population aged 60 years and over, Krabi
and Nakhon Si Thammarat provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

Not all districts have prisons, but overall, there were more prisoners in Nakhon Si Thammarat than in Krabi (Figure 59).
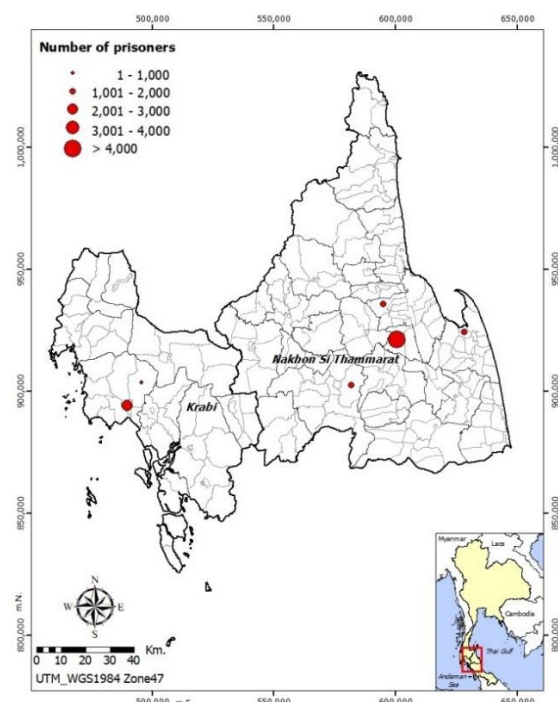
Figure 59: Number of prisoners in Krabi and Nakhon Si Thammarat provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

Numbers of orphans and homeless people were very small in both provinces. Only one district in Nakhon Si Thammarat province had more than 400 orphans and homeless people (Figure 60).
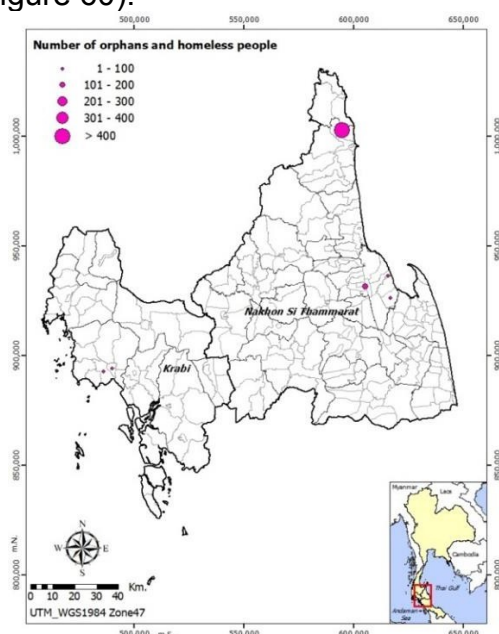
Figure 60: Number of orphans and homeless people in Krabi and Nakhon Si Thammarat provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

All districts in both provinces had disabled persons (Figure 61). Only one district (Mueang Krabi) in Krabi compared to three districts (Tha Sala, Mueang Nakhon Si Thammarat and Thung Song) in Nakhon Si Thammarat had at least 750 persons living with disabilities.
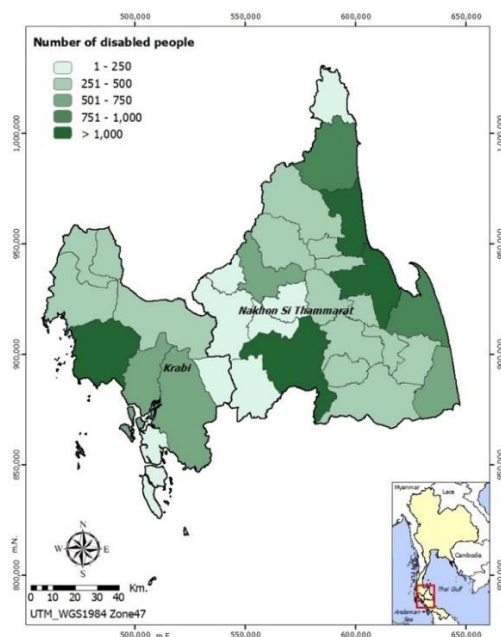
Figure 61: Number of disabled persons in Krabi and
Nakhon Si Thammarat Provinces, 2017
Source: Department of Provincial Administration, Ministry of Interior, 2017

Chronic diseases were prevalent in both provinces (Figure 62). Most districts in both
Krabi and Nakhon Si Thammarat provinces had more than 7% of their population
living with a particular chronic ailment.
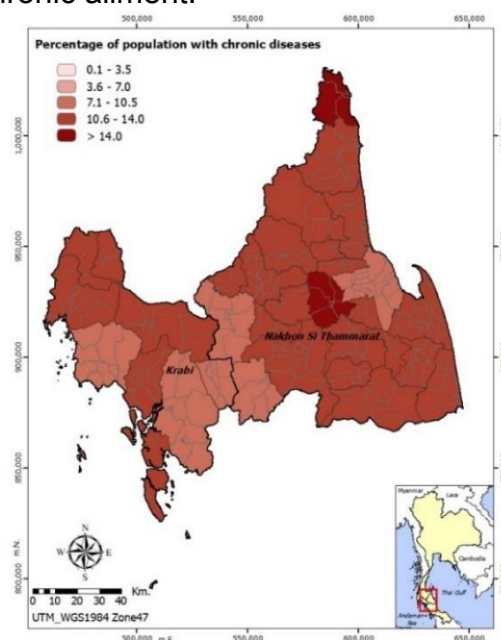
Figure 62: Proportion of population with chronic diseases in Krabi and
Nakhon Si Thammarat Provinces, 2017
Source: Provincial Public Health Office, Ministry of Public Health, 2019

Between the two provinces, Krabi had the largest area and most number of districts
covered by mangrove forests (Figure 63).
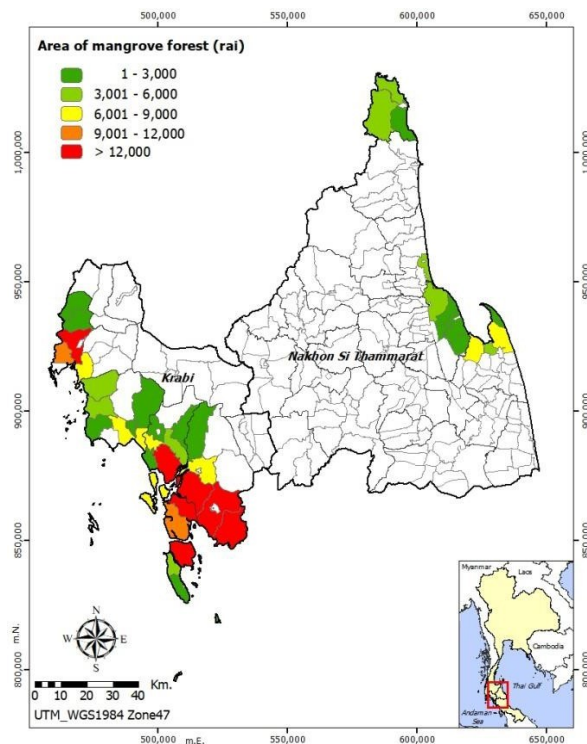
Figure 63: Area of mangrove forest (rai), 2017

5.3.2.3 Soft coping capacities

Literacy rate was included in this assessment as the only soft copying capacity (Figure 64). In both Krabi and Nakhon Si Thammarat provinces, all districts had a literacy rate between 90% and 95% among people aged 6 years and above.
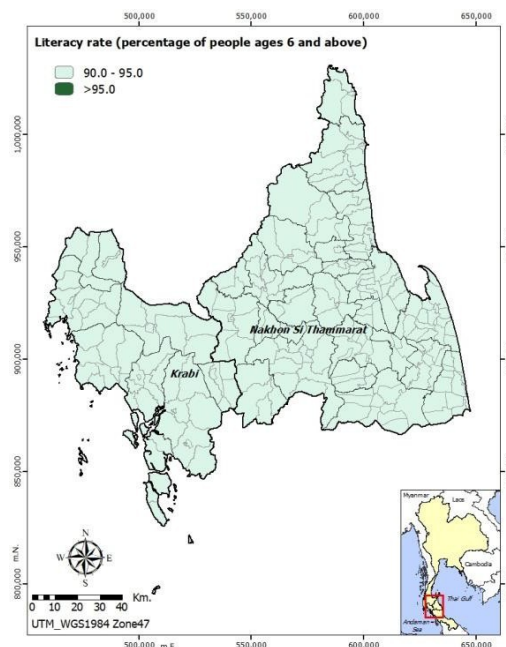
Figure 64: Literacy rate among people aged 6 years and above, 2017

5.3.2.4 Hard coping capacities

In both provinces, Tambon Health Promoting Hospitals were available in most of the Tambon areas (Figure 65).
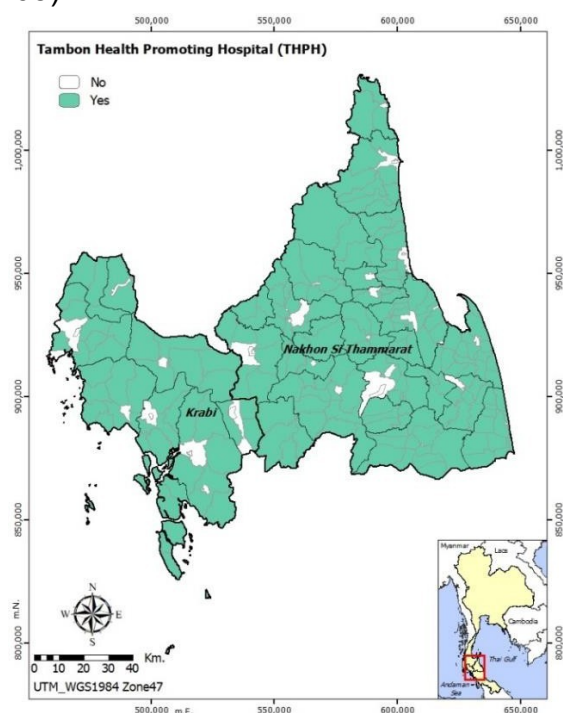
Figure 65: Availability of hospitals at sub-district level, 2017

All districts in both provinces were at least covered by either a functional hospital, either at community level, district level or regional level (Figure 66).
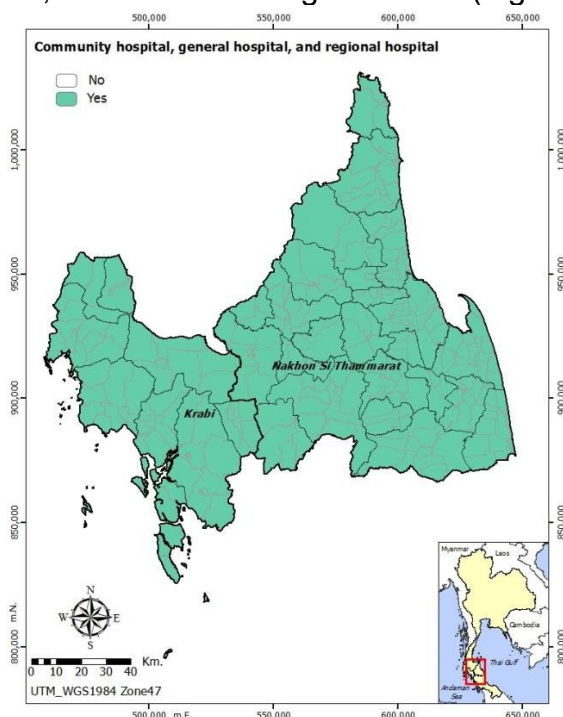
Figure 66: Availability of a hospital at district and provincial level, 2017

Very few districts in both provinces had ICT master plans in place, however, Nakhon Si Thammarat had more Tambon areas with the master plans compared to Krabi province (
Figure 67).
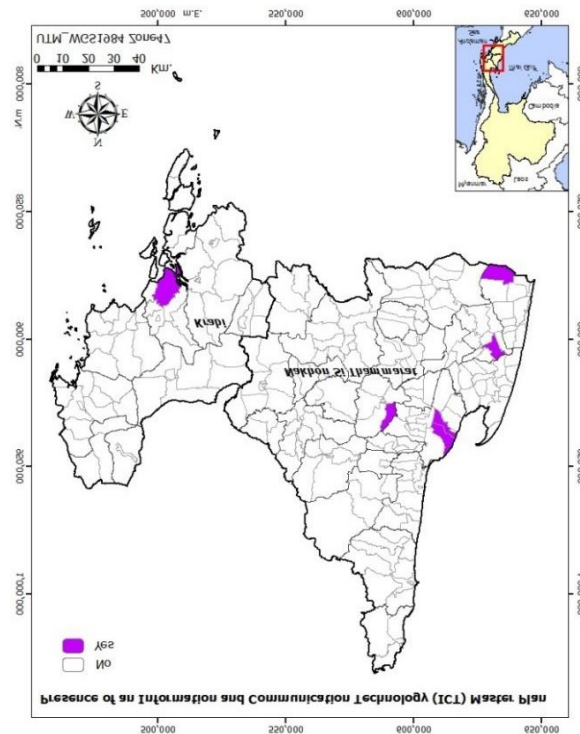
Figure 67: Presence of Information and
Communication Technology (ICT) Master plans, 2017

An assessment of resilience to water-related disasters was structured around the two main characteristics:

1) In each variable on exposure and vulnerability, score was placed on a scale between 0 and 5. The total score was computed by summing the scores, and range from 0 to 45, with lower scores indicating greater resilience.
2) Coping capacity (hard and soft) scores range from 0 to 4.

Based on data collected, variables of exposure, vulnerability, soft coping capacities, and hard coping capacities were developed in a scale in each of 61 (48 Subdistrict Administration Organizations, 12 Subdistrict Municipalities, 1 Town Municipality) and 184 (130 Subdistricts Administration Organizations, 50 Subdistrict Municipalities, 3 Town Municipalities, 1 City Municipality) in Krabi and Nakhon Si Thammarat provinces, respectively as shown in Table 15 and Table 16.

Table 15: Scores for resilience to water-related disasters in Krabi province

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)										Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest	Scores (Max 45)	Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	Scores (Max 4)
Mueang Krabi	Khao Khram	2	4	4	3	0	0	5	3	2	23	1	1	1	0	3
	Khao Thong	1	4	4	3	0	0	5	3	2	22	1	1	1	0	3
	Thap Prik	1	4	4	3	0	0	5	3	0	20	1	1	1	0	3
	Sai Thai	2	4	4	2	0	1	5	3	3	24	1	1	1	0	3
	Ao Nang	1	4	5	2	0	0	5	3	0	20	1	1	1	0	3
	Nong Thale	1	4	4	3	0	0	5	3	1	21	1	1	1	0	3
	Khlong Prasong	1	4	5	2	0	0	5	3	3	23	1	1	1	0	3
	Krabi Noi Subdistrict Municipality	1	4	4	3	1	0	5	3	1	22	1	1	1	0	3
	Mueang Krabi Town Municipality	5	3	4	3	3	1	5	3	1	28	1	0	1	0	2
Khao Phanom	Khao Phanom	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Khao Din	1	4	4	3	0	0	2	4	0	18	1	1	1	0	3
	Sin Pun	1	3	4	2	0	0	2	4	0	16	1	1	1	0	3
	Phru Tiao	1	4	4	3	0	0	2	4	0	18	1	1	1	0	3
	Na Khao	1	4	4	2	0	0	2	4	0	17	1	1	1	0	3
	Khok Han	1	3	4	2	0	0	2	4	0	16	1	1	1	0	3
	Khao Phanom Subdistrict Municipality	3	3	5	2	0	0	2	4	0	19	1	0	1	0	2
Ko Lanta	Ko Lanta Yai	1	5	5	2	0	0	1	4	1	19	1	1	1	0	3
	Ko Lanta Noi	1	4	5	2	0	0	1	4	5	22	1	1	1	0	3
	Ko Klang	1	4	4	3	0	0	1	4	4	21	1	1	1	0	3
	Khlong Yang	1	4	4	3	0	0	1	4	5	22	1	1	1	0	3
	Sala Dan	1	4	5	2	0	0	1	4	2	19	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)									Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Ko Lanta Yai Subdistrict Municipality	5	4	4	4	0	0	1	4	0	22	1	0	1	0	2
Khlong Thom	Khlong Thom Tai	1	4	4	3	0	0	3	3	3	21	1	0	1	0	2
	Khlong Thom Nuea	1	4	4	2	0	0	3	3	0	17	1	1	1	0	3
	Khlong Phon Phatthana Subdistrict Municipality	1	4	4	3	0	0	3	3	5	23	1	1	1	0	3
	Sai Khao Subdistrict Municipality	1	4	4	3	0	0	3	3	5	23	1	1	1	0	3
	Huai Nam Khao	1	4	4	3	0	0	3	3	5	23	1	1	1	0	3
	Phru Din Na	1	3	4	3	0	0	3	3	0	17	1	1	1	0	3
	Phela	1	4	4	3	0	0	3	3	1	19	1	1	1	0	3
	Khlong Phon Subdistrict Municipality	2	3	4	3	0	0	3	3	0	18	1	0	1	0	2
	Khlong Thom Tai Subdistrict Municipality	5	2	4	3	0	0	3	3	0	20	1	0	1	0	2
Ao Luek	Ao Luek Tai	1	3	4	3	0	0	2	4	5	22	1	0	1	0	2
	Laem Sak	1	3	3	3	0	0	2	4	4	20	1	1	1	0	3
	Na Nuea	1	2	3	4	0	0	2	4	1	17	1	1	1	0	3
	Khlong Hin	1	4	5	3	0	0	2	4	0	19	1	1	1	0	3
	Ao Luek Noi	1	4	4	2	0	0	2	4	3	20	1	1	1	0	3
	Ao Luek Nuea	1	3	3	3	0	0	2	4	0	16	1	1	1	0	3
	Khao Yai	1	3	4	3	0	0	2	4	1	18	1	1	1	0	3
	Khlong Ya	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Ban Klang	1	4	4	3	0	0	2	4	0	18	1	1	1	0	3
	Ao Luek Tai Subdistrict Municipality	4	3	3	4	0	0	2	4	0	20	1	0	1	0	2
	Laem Sak Subdistrict Municipality	3	3	4	3	0	0	2	4	0	19	1	0	1	0	2

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
Plai Phraya	Plai Phraya	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Khao Khen	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Khao To	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Khiri Wong	1	3	3	3	0	0	2	4	0	16	1	1	1	0	3
	Plai Phraya Subdistrict Municipality	3	3	4	3	0	0	2	4	0	19	1	0	1	0	2
Lam Thap	Lam Thap	1	4	5	2	0	0	1	3	0	16	1	0	1	0	2
	Din Udom	1	3	4	3	0	0	1	3	0	15	1	1	1	0	3
	Thung Sai Thong	1	4	4	2	0	0	1	3	0	15	1	1	1	0	3
	Din Daeng	1	3	4	3	0	0	1	3	0	15	1	1	1	0	3
	Lam Thap Subdistrict Municipality	3	3	4	3	0	0	1	3	0	17	1	0	1	0	2
Nuea Khlong	Nuea Khlong	2	4	4	2	0	0	3	4	1	20	1	0	1	0	2
	Ko Si Boya	1	3	4	3	0	0	3	4	3	21	1	1	1	0	3
	Khlong Khanan	1	4	4	3	0	0	3	4	5	24	1	1	1	1	4
	Khlong Khamao	2	4	4	3	0	0	3	4	3	23	1	1	1	0	3
	Khok Yang	1	4	4	3	0	0	3	4	1	20	1	1	1	0	3
	Taling Chan	2	4	4	3	0	0	3	4	1	21	1	1	1	0	3
	Pakasai	1	3	3	3	0	0	3	4	2	19	1	1	1	0	3
	Huai Yung	1	4	4	3	0	0	3	4	0	19	1	1	1	0	3
	Nuea Khlong Subdistrict Municipality	5	2	4	4	0	0	3	4	0	22	1	0	1	0	2

[1] Number of disabled persons at district level; prevalence of chronic diseases at district level

[2] Literacy rate at regional level

Table 16: Scores for resilience to water-related disasters in Nakhon Si Thammarat province

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)									Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
Mueang Nakhon Si Thammarat	Tha Rai	1	3	3	4	0	0	5	3	1	20	1	1	1	0	3
	Pak Nakhon	1	3	3	3	0	0	5	3	1	19	1	1	1	1	4
	Na Sai	1	4	3	3	0	0	5	3	0	19	1	1	1	0	3
	Kamphaeng Sao	2	3	3	4	0	0	5	3	0	20	1	1	1	0	3
	Chai Montri	2	3	3	4	0	0	5	3	0	20	1	1	1	0	3
	Mamuang Song Ton	2	3	3	4	0	0	5	3	0	20	1	1	1	0	3
	Na Khian	3	4	4	3	0	0	5	3	0	22	1	1	1	0	3
	Tha Ngio Subdistrict Municipality	1	3	3	4	2	0	5	3	0	21	1	1	1	0	3
	Pho Sadet Subdistrict Municipality	2	3	3	4	0	0	5	3	0	20	1	1	1	0	3
	Bang Chak	2	2	3	4	0	1	5	3	1	21	1	1	1	0	3
	Pak Phun Town Municipality	3	3	3	3	0	0	5	3	2	22	1	1	1	0	3
	Tha Sak	2	3	3	3	0	0	5	3	1	20	1	1	1	1	4
	Tha Ruea	2	3	3	4	0	0	5	3	0	20	1	1	1	0	3
	Pak Nakhon Subdistrict Municipality	5	3	3	4	0	1	5	3	0	24	1	0	1	0	2
	Bang Chak Subdistrict Municipality	4	2	3	4	0	0	5	3	0	21	1	0	1	0	2
	Tha Pae Subdistrict Municipality	5	3	3	4	0	0	5	3	0	23	1	0	1	0	2
	Nakhon Si Thammarat City Municipality	5	3	3	4	0	2	5	3	0	25	1	0	1	0	2
Phrom Khiri	Phrom Khiri Subdistrict Municipality	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Ban Ko	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	In Khiri	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3
	Thon Hong	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Na Riang	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Phrommalok Subdistrict Municipality	3	2	3	4	0	0	2	4	0	18	1	0	1	0	2
	Thon Hong Subdistrict Municipality	2	2	5	3	0	0	2	4	0	18	1	0	1	0	2
Lan Saka	Khao Kaeo	1	3	3	4	0	0	2	5	0	18	1	1	1	0	3
	Lan Saka	1	3	3	4	0	0	2	5	0	18	1	1	1	0	3
	Tha Di	1	2	3	5	0	0	2	5	0	18	1	1	1	1	4
	Kamlon	1	2	3	4	0	0	2	5	0	17	1	1	1	0	3
	Khun Thale Subdistrict Municipality	1	3	3	4	0	0	2	5	0	18	1	1	1	0	3
	Lan Saka Subdistrict Municipality	4	2	3	4	0	0	2	5	0	20	1	0	1	0	2
Chawang	Pak Nam Chawang Subdistrict Municipality	1	4	4	4	0	0	3	4	0	20	1	1	1	0	3
	La-ai	1	3	3	4	0	0	3	4	0	18	1	1	1	0	3
	Na Wae	1	3	3	4	0	0	3	4	0	18	1	1	1	0	3
	Mai Riang	1	3	3	4	0	0	3	4	0	18	1	1	1	0	3
	Kapiat	1	2	3	4	0	0	3	4	0	17	1	1	1	0	3
	Na Kacha	1	2	3	5	0	0	3	4	0	18	1	1	1	0	3
	Huai Prik	1	2	3	4	0	0	3	4	0	17	1	1	1	0	3
	Saira	1	3	3	4	0	0	3	4	0	18	1	0	1	0	2
	Na Khliang	1	2	3	5	0	0	3	4	0	18	1	1	1	0	3
	Mai Riang Subdistrict Municipality	5	3	3	4	0	0	3	4	0	22	1	0	1	0	2
	Chawang Subdistrict Municipality	5	2	3	5	0	0	3	4	0	22	1	0	1	0	2

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Chan Di Subdistrict Municipality	2	3	3	4	0	0	3	4	0	19	1	1	1	0	2
Phipun	Phipun	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3
	Kathun Subdistrict Municipality	1	2	3	5	0	0	2	4	0	17	1	1	1	0	3
	Yang Khom	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Khuan Klang Subdistrict Municipality	1	3	3	5	0	0	2	4	0	18	1	1	1	0	3
	Khao Phra Subdistrict Municipality	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Phipun Subdistrict Municipality	5	3	3	4	0	0	2	4	0	21	1	0	1	0	2
Chian Yai	Chian Yai	1	2	3	5	0	0	2	4	0	17	1	0	1	0	2
	Tha Khanan	1	2	2	5	0	0	2	4	0	16	1	1	1	0	3
	Ban Noen	1	2	3	5	0	0	2	4	0	17	1	1	1	1	4
	Sai Mak	1	2	3	5	0	0	2	4	0	17	1	1	1	0	3
	Thong Lamchiak	1	2	3	5	0	0	2	4	0	17	1	1	1	0	3
	Suea Hueng	1	2	2	5	0	0	2	4	0	16	1	1	1	0	3
	Karaket Subdistrict Municipality	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Khao Phra Bat	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Mae Chao Yu Hua	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Chian Yai Subdistrict Municipality	5	1	2	5	0	0	2	4	0	19	1	0	1	0	2
Cha-uat	Cha-uat	2	3	3	4	0	0	2	4	0	18	1	1	1	0	3
	Tha Samet	3	3	3	4	0	0	2	4	0	19	1	1	1	0	3
	Tha Pracha Subdistrict Municipality	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3
	Khreng	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Wang Ang	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Ban Tun	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Khon Hat	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3
	Ko Khan	2	2	3	4	0	0	2	4	0	17	1	1	1	0	3
	Khuan Nong Hong	1	3	3	3	0	0	2	4	0	16	1	1	1	0	3
	Khao Phra Thong	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Nang Long	1	2	3	4	0	0	2	4	0	16	1	1	1	0	3
	Cha-uat Subdistrict Municipality	5	2	4	4	0	0	2	4	0	21	1	0	1	0	2
Tha Sala	Tha Sala	5	4	4	3	0	0	5	4	2	27	1	0	1	0	2
	Klai	2	3	3	4	0	0	5	4	0	21	1	1	1	0	3
	Tha Khuen	2	3	3	4	0	0	5	4	0	21	1	1	1	0	3
	Hua Taphan	1	3	3	4	0	0	5	4	0	20	1	1	1	0	3
	Sa Kaeo	2	2	3	4	0	0	5	4	0	20	1	1	1	0	3
	Mokkhalan	2	4	4	3	0	0	5	4	0	22	1	1	1	0	3
	Thai Buri	2	3	3	4	0	0	5	4	0	21	1	1	1	0	3
	Don Tako	1	3	3	4	0	0	5	4	0	20	1	1	1	0	3
	Taling Chan	1	3	4	3	0	0	5	4	0	20	1	1	1	0	3
	Pho Thong	2	4	4	3	0	0	5	4	0	22	1	1	1	0	3
	Tha Sala Subdistrict Municipality	5	2	3	5	0	0	5	4	0	24	1	0	1	0	2
Thung Song	Chamai Subdistrict Municipality	4	4	3	4	0	0	5	4	0	24	1	1	1	0	3
	Nong Hong	1	3	4	4	0	0	5	4	0	21	1	1	1	0	3
	Khuan Krot	2	3	4	4	0	0	5	4	0	22	1	1	1	0	3
	Na Mai Phai	1	4	4	3	0	0	5	4	0	21	1	1	1	0	3
	Na Luang Sen	1	3	3	4	0	0	5	4	0	20	1	1	1	0	3
	Khao Ro	1	3	4	3	0	0	5	4	0	20	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Kapang Subdistrict Municipality	1	3	3	2	0	0	5	4	0	18	1	1	1	0	3
	Namtok	1	5	4	3	0	0	5	4	0	22	1	1	1	0	3
	Tham Yai Subdistrict Municipality	1	4	3	3	2	0	5	4	0	22	1	1	1	0	3
	Na Pho	2	3	4	4	0	0	5	4	0	22	1	1	1	0	3
	Khao Khao	1	3	4	3	0	0	5	4	0	20	1	1	1	0	3
	Ti Wang Subdistrict Municipality	1	3	4	3	0	0	5	4	0	20	1	1	1	0	3
	Thung Song Town Municipality	5	3	3	3	0	0	5	4	0	23	1	0	1	0	2
Na Bon	Na Bon	1	3	3	4	0	0	1	4	0	16	1	1	1	0	3
	Thung Song	1	3	4	4	0	0	1	4	0	17	1	1	1	0	3
	Kaeo Saen	1	3	4	4	0	0	1	4	0	17	1	1	1	0	3
	Na Bon Subdistrict Municipality	4	3	3	4	0	0	1	4	0	19	1	0	1	0	2
Thung Yai	Tha Yang	1	4	4	3	0	0	1	3	0	16	1	0	1	0	2
	Thung Sang Subdistrict Municipality	1	4	4	3	0	0	1	3	0	16	1	1	1	0	3
	Thung Yai	1	3	4	4	0	0	1	3	0	16	1	1	1	0	3
	Kurae	1	4	4	3	0	0	1	3	0	16	1	1	1	0	3
	Prik	1	3	4	3	0	0	1	3	0	15	1	1	1	0	3
	Bang Rup	1	4	4	3	0	0	1	3	0	16	1	1	1	0	3
	Krung Yan	1	3	4	3	0	0	1	3	0	15	1	1	1	0	3
	Tha Yang Subdistrict Municipality	5	3	4	3	0	0	1	3	0	19	1	0	1	0	2
Pak Phanang	Khlong Noi	1	3	3	4	0	0	4	4	3	22	1	1	1	0	3
	Pa Rakam	1	3	3	5	0	0	4	4	0	20	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Chamao Subdistrict Municipality	1	2	3	5	0	0	4	4	0	19	1	1	1	0	3
	Khlong Krabue	1	2	3	5	0	0	4	4	0	19	1	1	1	0	3
	Ko Thuat Subdistrict Municipality	1	3	3	5	0	0	4	4	0	20	1	1	1	0	3
	Ban Mai	2	2	3	5	0	0	4	4	0	20	1	1	1	0	3
	Hu Long	2	2	3	4	0	0	4	4	0	19	1	1	1	0	3
	Laem Talumphuk	1	3	3	4	0	0	4	4	1	20	1	1	1	0	3
	Pak Phanang Fang Tawantok	2	3	3	4	2	0	4	4	2	24	1	1	1	0	3
	Bang Sala	1	2	3	5	0	0	4	4	0	19	1	1	1	0	3
	Bang Phra Subdistrict Municipality	2	3	3	4	0	0	4	4	0	20	1	1	1	0	3
	Pak Phanang Fang Tawan-ok	2	4	3	3	0	0	4	4	3	23	1	1	1	0	3
	Ban Phoeng	1	2	2	4	0	0	4	4	0	17	1	1	1	0	3
	Tha Phaya	2	3	3	4	0	0	4	4	0	20	1	1	1	0	3
	Pak Phraek	1	3	3	5	0	0	4	4	0	20	1	1	1	0	3
	Khanap Nak	1	2	3	5	0	0	4	4	0	19	1	1	1	0	3
	Pak Phanang Town Municipality	5	3	3	4	0	0	4	4	0	23	1	0	1	0	2
Ron Phibun	Ron Phibun	2	3	3	4	0	0	2	4	0	18	1	0	1	0	2
	Hin Tok	1	3	3	3	0	0	2	4	0	16	1	1	1	0	3
	Sao Thong	2	3	3	4	0	0	2	4	0	18	1	1	1	0	3
	Khuan Phang	2	3	4	4	0	0	2	4	0	19	1	1	1	0	3
	Khuan Chum	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Hin Tok Subdistrict Municipality	4	3	3	4	0	0	2	4	0	20	1	0	1	0	2

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)								Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)			Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Ron Phibun Subdistrict Municipality	4	3	3	4	0	0	2	4	0	20	1	0	1	0	2
	Khao Chum Thong Subdistrict Municipality	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
Sichon	Sichon	2	4	4	3	0	0	4	4	0	21	1	0	1	0	2
	Thung Prang	2	3	3	4	0	0	4	4	0	20	1	1	1	0	3
	Chalong	1	2	3	5	0	0	4	4	0	19	1	1	1	0	3
	Sao Phao	2	3	3	4	0	0	4	4	0	20	1	1	1	0	3
	Plian	1	2	3	4	0	0	4	4	0	18	1	1	1	0	3
	Si Khit	1	4	4	3	0	0	4	4	0	20	1	1	1	0	3
	Theppharat	1	3	3	4	0	0	4	4	0	19	1	1	1	0	3
	Khao Noi	1	3	3	4	0	0	4	4	0	19	1	1	1	0	3
	Thung Sai Subdistrict Municipality	1	3	4	3	0	5	4	4	0	24	1	1	1	0	3
	Sichon Subdistrict Municipality	5	3	3	4	0	0	4	4	0	23	1	0	1	0	2
Khanom	Ao Khanom Subdistrict Municipality	1	3	3	4	0	0	1	5	1	18	1	1	1	0	3
	Khuan Thong	1	2	3	4	0	0	1	5	2	18	1	1	1	0	3
	Thong Nian Subdistrict Municipality	1	3	3	3	0	0	1	5	2	18	1	1	1	0	3
	Khanom Subdistrict Municipality	5	4	3	4	0	0	1	5	0	22	1	0	1	0	2
Hua Sai	Hua Sai	1	3	3	4	0	0	3	4	0	18	1	1	1	0	3
	Sai Khao	1	3	3	4	0	0	3	4	0	18	1	1	1	0	3
	Laem	1	3	3	5	0	0	3	4	0	19	1	1	1	0	3
	Khao Phang Krai	1	3	3	5	0	0	3	4	0	19	1	1	1	0	3
	Ban Ram	1	2	3	4	0	0	3	4	0	17	1	1	1	0	3
	Bang Nop	1	3	3	4	0	0	3	4	0	18	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5) Population density	Vulnerability[1] (Scale 0-5) Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest	Scores (Max 45)	Soft coping capacities[2] (Scale 0-1) Education	Hard coping capacities (Scale 0-1) Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	Scores (Max 4)
	Tha Som	1	3	3	5	0	0	3	4	0	19	1	1	1	0	3
	Khuan Chalik	1	2	3	5	0	0	3	4	0	18	1	1	1	1	4
	Ram Kaeo	1	2	3	5	0	0	3	4	0	18	1	1	1	0	3
	Na Saton Subdistrict Municipality	2	3	3	4	0	0	3	4	0	19	1	1	1	0	3
	Ko Phet Subdistrict Municipality	2	3	3	4	0	0	3	4	0	19	1	1	1	0	3
	Hua Sai Subdistrict Municipality	5	3	4	4	0	0	3	4	0	23	1	0	1	0	2
Bang Khan	Bang Khan	1	4	4	2	0	0	1	3	0	15	1	1	1	0	3
	Ban Lamnao	1	4	4	2	0	0	1	3	0	15	1	1	1	0	3
	Wang Hin	1	3	4	3	0	0	1	3	0	15	1	1	1	0	3
	Ban Nikhom	1	3	4	3	0	0	1	3	0	15	1	1	1	0	3
Tham Phannara	Tham Phannara	1	3	4	3	0	0	1	4	0	16	1	1	1	0	3
	Khlong Se	1	4	4	3	0	0	1	4	0	17	1	1	1	0	3
	Dusit	1	3	4	3	0	0	1	4	0	16	1	1	1	0	3
Chulabhorn	Ban Cha-uat	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Khuan Nong Khwa	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Thung Pho	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Na Mo Bun	1	3	3	3	0	0	2	4	0	16	1	1	1	0	3
	Sam Tambon	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
Phra Phrom	Na Phru	2	3	3	3	5	0	2	4	0	22	1	1	1	0	3
	Na San Subdistrict Municipality	2	3	3	4	0	0	2	4	0	18	1	1	1	0	3
	Thai Samphao	2	3	3	4	0	0	2	4	0	18	1	1	1	0	3
	Chang Sai	2	3	3	4	0	0	2	4	0	18	1	1	1	0	3
Nopphitam	Nopphitam	1	3	4	3	0	0	2	4	0	17	1	1	1	0	3
	Krung Ching	1	3	4	2	0	0	2	4	0	16	1	1	1	0	3

District	Subdistrict Administration Organization/Municipality	Exposure (Scale 0-5)	Vulnerability[1] (Scale 0-5)									Scores (Max 45)	Soft coping capacities[2] (Scale 0-1)	Hard coping capacities (Scale 0-1)				Scores (Max 4)
		Population density	Infant	Children under the age of five	Elderly population	Prisoners	Orphans and homeless persons	Disabled persons	Chronic diseases	Mangrove forest		Education	Hospital at subdistrict level	Hospital at district and provincial level	Telecommunication development	
	Karo	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Na Reng Subdistrict Municipality	1	3	3	3	0	0	2	4	0	16	1	1	1	0	3
Chang Klang	Chang Klang	1	2	3	4	0	0	1	4	0	15	1	1	1	0	3
	Lak Chang Subdistrict Municipality	1	3	3	4	0	0	1	4	0	16	1	1	1	0	3
	Suan Khan Subdistrict Municipality	1	2	3	4	0	0	1	4	0	15	1	1	1	0	3
Chaloem Phra Kiat	Chian Khao	1	3	3	5	0	0	2	4	0	18	1	1	1	0	3
	Don Tro	2	2	3	4	0	0	2	4	0	17	1	1	1	0	3
	Suan Luang	1	3	3	4	0	0	2	4	0	17	1	1	1	0	3
	Thang Poon Subdistrict Municipality	2	3	3	4	0	0	2	4	0	18	1	1	1	0	3

[1] Number of disabled persons at district level; prevalence of chronic diseases at district level

[2] Literacy rate at regional level

Figure 68 below provides a summary of the exposure and vulnerability resilience scores for Krabi province by district. Out of a possible total of 45, Mueang Krabi had the least average resilience score of 23. Lam Thap sub-district had the greatest resilience with a score of 16 out of 45. However, district averages mask the variations among sub-district scores. The sub district with the least resilience in terms of exposure and vulnerability to water related disasters was Mueang Krabi municipality.
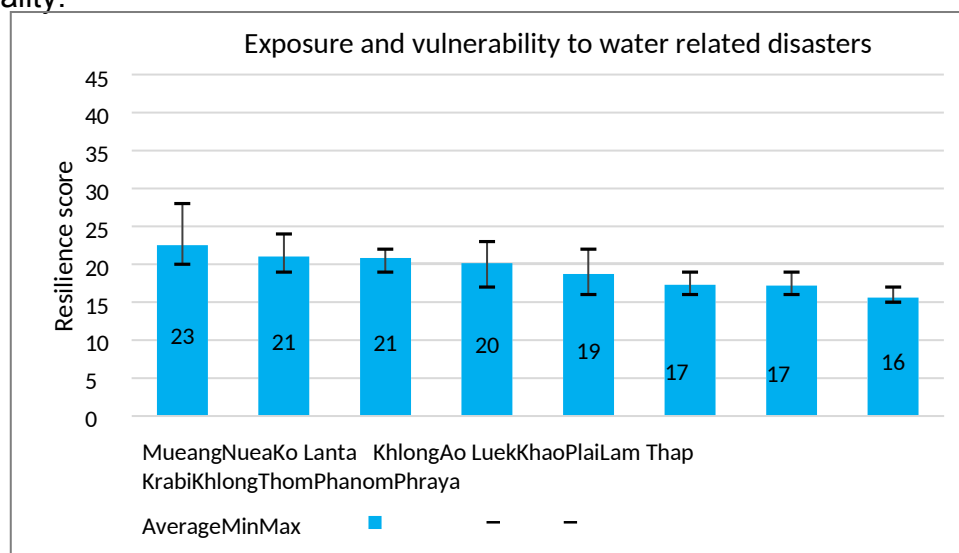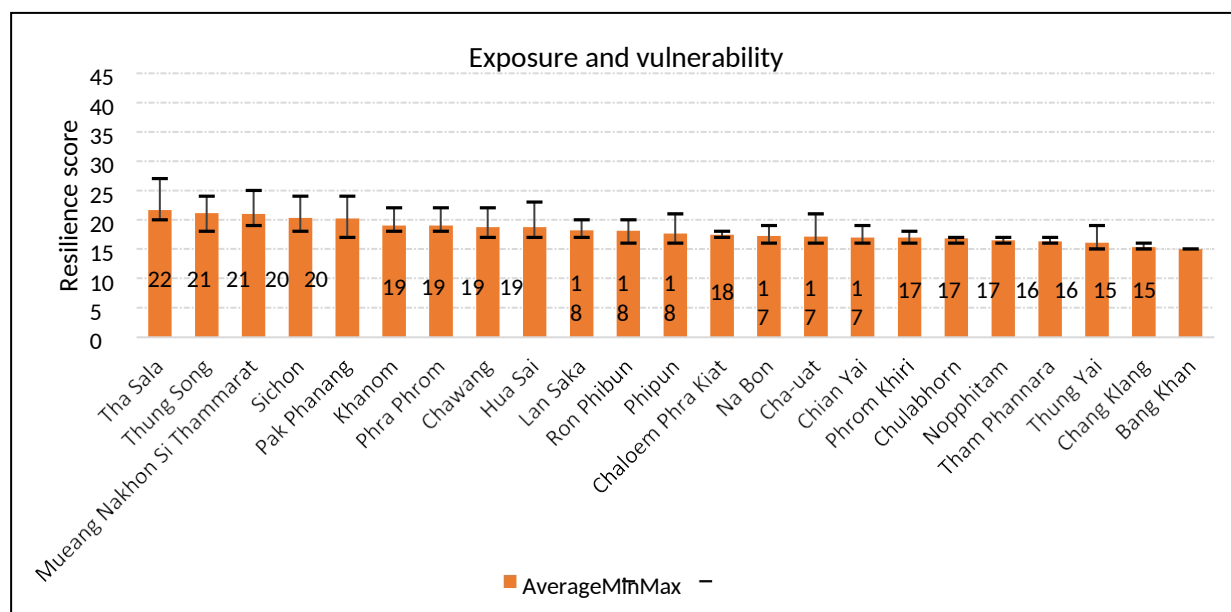

Figure 68: Summary scores for exposure and
vulnerability to water-related disasters in Krabi province

In terms of soft and hard coping capacities, the average resilience score across districts was 3 out of a possible 4, meaning that most of the districts are quite resilient (see
Figure 69). In Nuea Khlong district, Khlong Khanan had the highest resilience score possible.
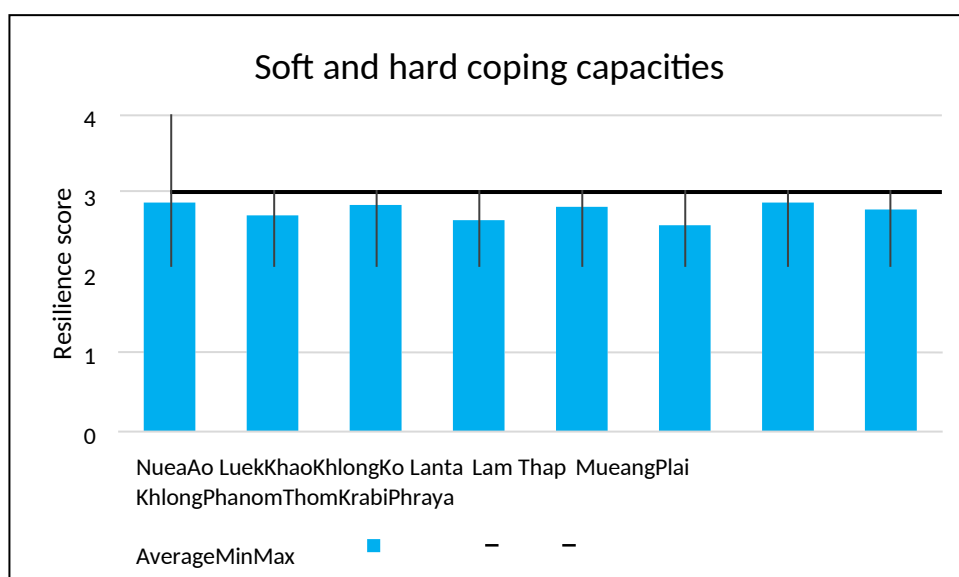
Figure 69: Summary scores for coping capacity in Krabi province

Like Krabi Province, district average resilience scores for exposure and vulnerability to water related hazards mask the variations among sub-district scores. As shown in Figure 70, all districts had average resilience scores less than half of the maximum possible 45. However, there were several sub districts with scores above 25 out of 45. Tha Sala district was the least resilient to exposure and vulnerability, and Tha Sala sub district had the highest score of 27. The most resilient districts with the least scores were Chang Klang and Banh Khan, both with scores of 15 out of 45.

Figure 70: Summary scores for exposure and vulnerability to water-related disasters in Nakhon Si Thammarat province

With regards to the soft and hard coping capacities, the average resilience score across districts was 3 out of a possible 4, meaning that most of the districts are quite resilient (see Figure 71). In 4 of the districts, there were subdistricts with the highest score of 4 out of 4.
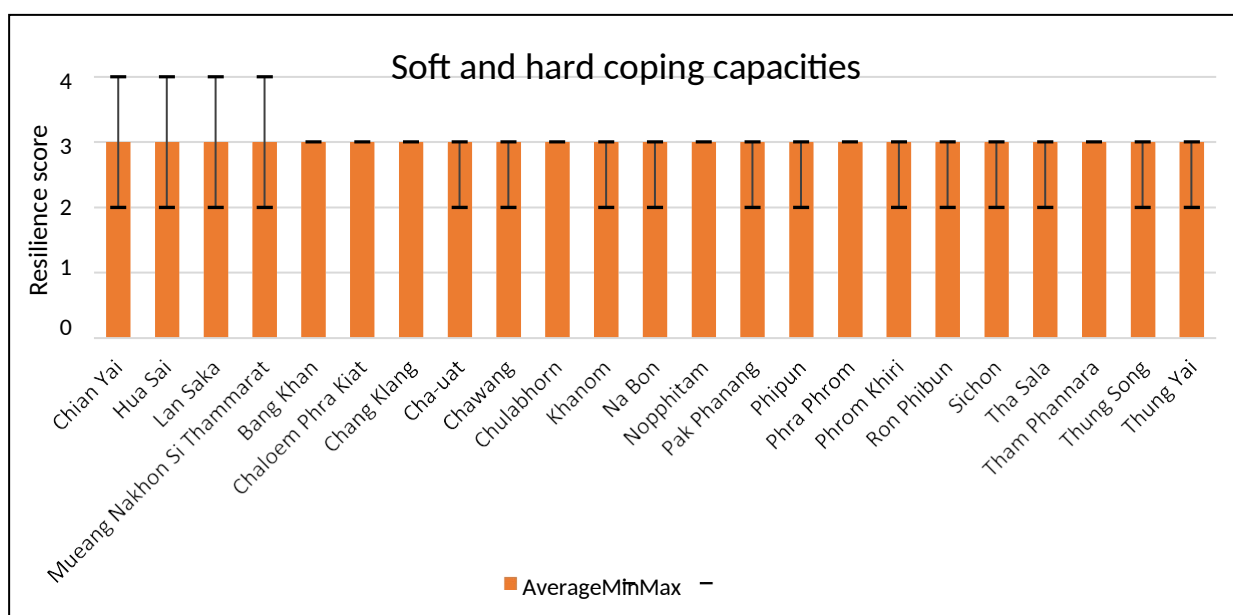
Figure 71: Summary scores for coping capacity in Nakhon Si Thammarat province

5.3.3 Coping mechanism

Coping mechanisms refer to the ability of people, organisations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters (Cardona et al., 2012). Coastal areas of Thailand are subjected to flooding situations, linked with storm activity, from time to time. Following the floods in 2004, the Thai Red Cross, in partnership with other agencies and with funding from UNDP, implemented a project designed to strengthen the adaptive capacity of vulnerable coastal communities in Thailand to climate change related risks and weather events. To increase the resilience of people residing in the affected areas, it was necessary to integrate climate change adaptation into provincial development plans and sector policies. With the successful implementation of the project in three provinces namely Nakhon Si Thammarat, Phatthalung and Trang, capacities of community groups and local authorities were strengthened through implementation of locally appropriate adaptation measures (UNDP, 2014).

Local production of life jackets, erection of village level early warning towers and sirens, community trainings in warning and evacuation drills were some of the coping mechanisms adopted in Thailand's coastal areas. Protecting existing mangrove areas, degraded mangrove rehabilitation activities, and the planting of Nipa palm trees generated additional income whilst protecting the areas from climate change related floods (UNDP, 2014). Mud dredging activities were carried out at community level, though some community members did not see it as useful hence were unwilling to cooperate in the activity (UNDP, 2014). Additional coping strategies include forest and watershed management which was carried out to mitigate the risks of river-floods with rubber plantations inter planted with different fruit tree species. Climate resilient/alternative rice production techniques, including rice bank and testing of flood resilient old rice varieties were amongst the successful strategies. Within the three provinces, another coping strategy was to improve radio network to connect upstream and downstream villages to mitigate the impacts of flash floods along the entire river basin (UNDP, 2014).

Following the 2004 Tsunami, households in Ban Nam Khem community organszed several disaster risk management activities by themselves and some in cooperation with the government. These included regular tsunami drills, pick-up services for elderly people in the case of an emergency, or the planning of escape routes and tsunami shelters (Willroth, Massmann, Wehrhahn, & Revilla Diez, 2012). Another coping mechanism in relation to the strengthening of social networks and community spirit was the common celebration of certain holidays, which were also used to carry out mitigation activities such as replanting degraded mangroves. The social cohesion within the affected community of Ban Nam Khem was important for binding the community together and developing successful coping mechanisms (Willroth et al., 2012).

In a study to determine households' adaptation strategies to address flooding, Jarungrattanapong and Manasboonphempool (2008) reported that households in Thailand had individually applied three types of autonomous coping mechanisms including protection (e.g., stone breakwaters, sandbags, bamboo revetments, and dike heightening), retreating (which implies that all-natural system effects can occur and human impacts are minimized by pulling back from the coast e.g. construction of new water gates) and accommodation (house re-building and renovation). Of these, protection was the most popular, and the study showed that individual coping strategies, without collective action to pull in one direction, may not be effective solutions due to the occurrence of negative externalities if the neighbours do not apply/maintain their own protection structures.

Efforts to increase resilience to water-related disasters should be guided by the Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations, 2015). This starts with gaining a better understanding of disaster risk and strengthening disaster risk governance to manage the risk (instead of managing the disaster after it happens) (Asian Development Bank, 2016). Key recommendations have been put forward to relocate vulnerable communities and populations e.g. the elderly, and infrastructure (schools, hospitals, and power stations) inland away from impacts of floods associated with coastal areas (UNDP, 2014). In addition, installation of dams and reservoirs as a knee-jerk solution to the freshwater problem must be avoided at all costs since it could exacerbate the impacts of flooding by impeding downstream flow of sediments. Rather than building dams, basin-wide water management should focus principally on conservation and efficient use of water (UNDP, 2014).

5.4 Discussion

This study provides a quantitative socioeconomic assessment conducted in two coastal provinces namely Krabi and Nakhon Si Thammarat to understand their vulnerabilities to hydro-meteorological hazards of varying magnitudes. In as much as disaster resilience is context-dependent, selection of variables included in this study was influenced by an earlier study in Thailand which highlighted the significance of parameters related to socio-economic characteristics compared to physical parameters (Duriyapong & Nakhapakorn, 2011). First, we assessed the social and economic dimensions independently, then combined the two dimensions leading to the development of socioeconomic resilience index maps.

From the social dimension, Nakhon Si Thammarat demographic population was almost three times that of Krabi province. A similar trend was observed for numbers of students and vulnerable groups including children under the age of one, children under five, and the elderly. Population density per square kilometre varied from one subdistrict to another within the two provinces suggesting that in terms of exposure to hydrometeorological hazards, some subdistricts were more vulnerable than others. More subdistricts in Krabi province had greater proportions of infants and children under 5 than in Nakhon Si Thammarat province. In contrast, most subdistricts in Nakhon Si Thammarat have higher proportions of the elderly population aged 60 and above. This has some implications when it comes to disaster response as the elderly and dependent people need prioritization, e.g., for emergency shelter or evacuation.

Both Krabi and Nakhon Si Thammarat provinces had similar rates of hospital in-patients per 100,000 population. However, the picture on the available public health resources was mixed. Apart from professional nurses, the numbers of all the other health professionals remain low with respect to the catchment areas they serve. Specialized care may not be adequate in the event of a surge in the numbers of patients due to unprecedented shocks from a natural disaster. Hospital beds were available at all levels of administration from community to sub-district to provincial level, and in different types of organizations including private sector, local government, independent organizations, Ministry of public health, other ministries, and state enterprises. The numerous transport networks connecting Krabi and Nakhon Si Thammarat provinces with the rest of Thailand provides enough options for conducting evacuations in the event of a hydrometeorological disaster.

The qualitative focus group discussions conducted as part of this assessment clearly showed that residents in the coastal provinces of Krabi and Nakhon Si Thammarat were resourceful and took initiatives to try and address the problem of coastal erosion in their areas, for example, through the establishment of conservation groups (see WP4 Report). The main challenge pertains to the limited resources needed to construct decent and stronger houses that can withstand hydrometeorological disasters. Whenever the government plans to establish some laws and regulations, local communities in the coastal provinces emphasised the need to conduct public hearings first, as this ensures that interventions proposed are context specific.

From an economic dimension, both Krabi and Nakhon Si Thammarat provinces have strategic areas of economic activity that are threatened by direct and indirect follow-on effects of hydrometeorological disasters. National parks, reserved forest areas, wildlife sanctuaries, cultural heritage sites and transport links are all part of the economy's backbone that would need to be protected against the adverse effects of hydrometeorological hazards. In this study, the social and economic dimensions were combined to derive a socio-economic resilience index for each subdistrict. The socioeconomic resilience index was based on exposure and vulnerability to hydrometeorological disasters, as well as the available coping capacities. Soft coping capacities referred to the personal qualities that enabled people to better manage risks, and literacy was used as a proxy indicator. High literacy rates were observed in all subdistricts, and this suggests that majority of people in coastal provinces of Krabi and Nakhon Si Thammarat had the ability to read and understand disaster related communication. Hard coping capacities referred available physical resources that

people relied on as they managed risks and disaster situations, and most subdistricts had high levels of coping capacities.

A limitation to note is that this report is based on secondary data, most of which came from different reference years. To some extent this affected the comparability of certain indicators between the two provinces under investigation. With the passage of time, some of the data may have been overtaken by events, making it obsolete. However, the researchers relied on the latest available secondary data at the time. The researchers also did not have control over the quality or completeness of data collected, as such, there may be gaps noticeable in some sections.

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Acknowledgments

Appendix A: Cultural heritage

Tradition and culture in Krabi

a. Likely Pa

In the past, Likey Pa became a part of the mass communication among the villagers as well as the "Nang Talung" (shadow play), "Nora" (folk dance), and other folk performances. In addition, the Likey Pa entertained the audience and became a channel of communications needed among villagers through the concise characters, poems, songs, and local dialect. It is like a mobile learning centre of culture in the traditional way of life, and acts as a refined social behaviour. Currently, the tradition of Likely Pa is likely to decrease in popularity due to the tide of change of globalization. The new generation is beginning to distance themselves from the cultural roots of traditional ways of life.

b. Nora

Nora is a form of traditional, folk performing arts that is also popular in the southern region of Thailand. The main elements and characteristics of Nora are the costume and the music. Nora is divided into two types: Nora for ritualistic ceremony, called Nora Rong Khru, and one for entertainment. Nora for ritualistic ceremony is a very important ritual dance for the Nora professionals. It is performed to invite the spirits of the Nora past masters to the ceremonial stage during the rite to pay homage and make offerings, and to initiate novices–the new generation of Nora performers. Besides its entertainment and the ritualistic values, Nora also serves as the media to disseminate news, messages, and information to the people, because it can easily access and communicate with the people.

c. Nang Talung

Nang Talung is a folk shadow puppet spectacle of the southern region of Thailand. It is a very popular kind of entertainment. Nang Talung tells a story in verses, which are sung (called "wa bot") in dialect, interspersed with dialogue, and uses the puppets' shadow on the screen to attract the audience attention. Besides its entertaining value, Nang Talung's lasting popularity from the past to the present also rests on the sharp wit of the puppeteer who comments on the prevailing social occurrences and happenings through the puppets. This reflects the character of the southern people who are keen on following social and political development and occurrences in the nation. Nang Talung has therefore been a part of the social and cultural landscape of the southern people throughout the ages.

d. Rong Ngen

Rong Ngeng is a folk performance art which originated from a foreign land and spread into throughout Koh Lanta. The art is used for performing rituals of fulfilling one's vows, making merit, and inhabiting new home. Rong Ngeng is also performed on the second

night for the floating ceremony to entertain fellow villagers who help make the floats and to prevent them from sleepiness while working on the floats.

e. Loi Ruea Chao Le Festival

This old ritualistic tradition takes place in Ko Lanta during the full moon of the sixth and eleventh month in the lunar calendar. This is a religious rite performed by the sea gypsies of Ko Lanta, as well as, from other neighbouring areas, who gather on the beach near Sala Dan Village. They dance their famous "rong ngeng" round the boats of misfortune to be set adrift. Ceremonies feature singing and dancing. This festival is expected to bring prosperity and happiness to the participants.

f. Sat Duean Sip Festival or Festival of the Tenth Lunar Month

This is the southern traditional merit making occasion to honour one's ancestors. Food offerings such as Khanom La, Khanom Chohu, Khanom Phong, Khanom Ba, and Khanom Kong or Khai Pla, are made to Buddhist monks.

g. Krabi Boek Fa Andaman Festival

This is annually held in November to inaugurate the province's tourist season. Water sports competitions, cultural shows, and good-natured fun characterize the festival.

h. Laanta Lanta Festival

This is held in March every year, and the festival's objective is to publicise Ko Lanta's ecotourism attractions as well as carry on the cultural heritage of the Muslim community and Thai Mai ethnic group. It also features various cultural performances, such as, rice pounding in the old way, Khuen Ple Klom Dek ritual (baby in candle spirit warming) and folk recreation.

i. Krabi Vegetarian Festival

The great vegetarian festival of Krabi with the participation of over 40 shrines in front of Krabi s city hall. Tourists will get to pay homage and witness the parade of gods and spiritualists of the shrines around the town andparticipate in religious ritual at the city's pillar shrine.

j. Mawlid al-Nabi Celebration

The Mawlid al-Nabi celebration in Thailand marks the birthday of the Prophet Muhammad, which is held by The Central Islamic Council of Thailand together with the government sector, charity foundations, and state enterprises. At the ceremony, respect is paid, and blessings are asked of the Prophet Muhammad. Thai Muslims

recite Al-Quran scriptures. Trade booths are organized for the sale of Muslim products and Halal foods, in addition to educational presentations.

Cultural tradition in Nakhon Si Thammarat province

a. *Hot Food Alms Offering to Monks*

This is a festival conducted during an episode cold weather to offer food to Buddhist monks. This festival involves making merit by putting food in the bowls of monks. Monks receive alms from people who believe they are gaining merit by giving.

b. *Hae Pha Khuen That Festival*

The key activity of this merit-making festival is the draping of a very long piece of yellow, holy cloth known as Phra Bot around the base of a stupa inside which Buddha's sacred relics are enshrined. Buddhist devotees donate money for purchasing cloth pieces that are sewn into one-piece thousands of yards long. The ritualistic cloth is carried in a procession that can be started inside or outside the temple grounds. Sometimes it is carried around the stupa. Draping the cloth around the relic stupa symbolizes the offering of the cloth to be put on the Lord Buddha.

c. *Suoddan Ritual*

The history of Suoddan Ritual at Wat Phra Mahathat Woramaha Vihara in Nakhon Si Thammarat was to chant by reading from a book in southern native language. It was originated because of believing in Buddhism and Buddha's relics stored at Wat Phra Mahathat Woramaha Vihara; it consists of many aspects of knowledge: development, society, unity in the community, and being proud of native.

d. *Khao* **Matupayas** *Making Ceremony*

The results showed that the custom of making Mathupayas Rice reflected Nakhon Si Thammarat people's beliefs and faith in Buddhism and the strict observation of their customs, which, in turn, led to the inheritance of both their customs and Buddhist practice. Besides, it reflected the way of life of people in Nakhon Si Thammarat concerning their rice farming and agricultural practice as well as their Buddhist way of life. Temples and monks also participated in the customs along with people and government agencies. This can be considered as the conservation of customs and traditions and the inheritance of virtuous wisdom.

e. *Kwankhao Tradition (Chian Yai Subdistrict, Chian Yai District)*

Kwankhao tradition is known to vary according to local customs agenda. Customary indemnification mother goddess of grain which in many provinces of Thailand. The cultivation a tradition that represents God's saving grace gratitude of rice cultured

human life and to ask for what offense. It is believed that on the agenda, it makes the product better.

f. Pit Greet Event (Na Bon District)

The main aim of the event was to enhance the morale and encouragement in rubber farmers during the period of stop tapping rubber.

g. Songkarn Festival (Si Thammasokarat Public Park, Mueang Nakhon Si Thammarat District)

Nakhon Si Thammarat is different from those of other provinces, given its unique environment and beliefs the highlight of the bathing ceremony for Phra Phuthasihing, major Buddah image, and the traditional procession of Nang Darn is an important tradition during the Songkran festival.

h. Hae Nang Dan Festival (Ho Phra Isuan, Mueang Nakhon Si Thammarat District)

Hae Nang Dan Festival is the ancient Brahman ritual in Nakhon Si Thammarat who believes in Shiva, the Brahman god. Paying homage to Shiva, the Brahman god for the New Year. This festival originated from Brahman community in 1200 AD. Brahman community moved to Ayutthaya and this festival was call Lo Ching Cha or Triyampayai festival in Ratthanakosin period. It has been cancelled in 1933.

i. Promotion of Buddhism Activities

Many activities will be held to provide knowledge and understanding of Buddhism, such as religious seminars and an exhibition of Phra Vessantara, the Lord Buddha's previous life. On May 18, which coincides with Visakha Bucha Day, a merit-making and alms-giving ceremony will be organized for the public, government officials, and representatives of the public and private sectors. Visakha Bucha Day is an important religious holiday for Buddhists worldwide.

j. Khanom Festival (Khanom District)

The Khanom Festival is back for its seventh year and scheduled to take place on 27 July 2019 at Khanom Island's famous Na Dan Beach in Nakhon Si Thammarat. Supported once again by the Khanom Tourism Association in cooperation with many generous sponsors, this year's fun music festival features performances by popular Thai singers and bands.

k. Tenth Lunar Month

The festival is celebrated on the last 10 days of the waning moon in September. According to local belief, this is when ancestors can visit their relatives. On this occasion, there are merit making ceremony for ancestors. The festival is a ten-day celebration at Phra Mahathat Temple and Princess Mother 84 public park.

I. Chak Phra Festival

At the start of the eleventh lunar month (usually in October) the locals celebrate the end of Buddhist Lent with the Chak Phra Festival which symbolizes the Buddha's return to earth after a monsoon season spent preaching to his mother in heaven. The significance of the tradition relates to both religious beliefs and monarchy.
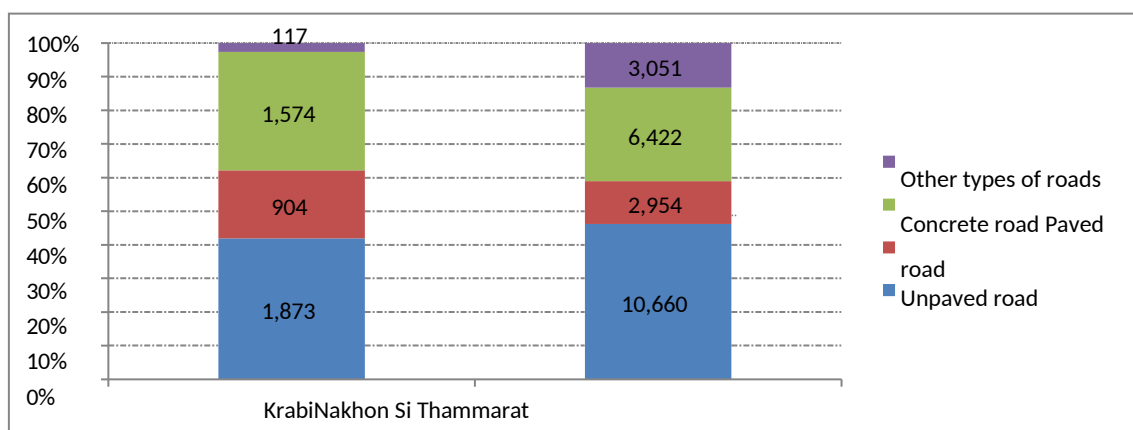
Appendix B: Well-being

Types of available roads

As shown in
Figure **72**, 40-50% of the roads in both Krabi and Nakhon Si Thammarat provinces are still unpaved.

Figure 72: Types of available roads
Source: Department of Local Administration, Ministry of Interior, 2018

Types of available bridges

Figure **73** shows the types of bridges available in Krabi and Nakhon Si Thammarat provinces. At least 90% of the bridges in either province is made of concrete, though the number of bridges in Nakhon Si Thammarat province is 5-times the number of bridges in Krabi province.
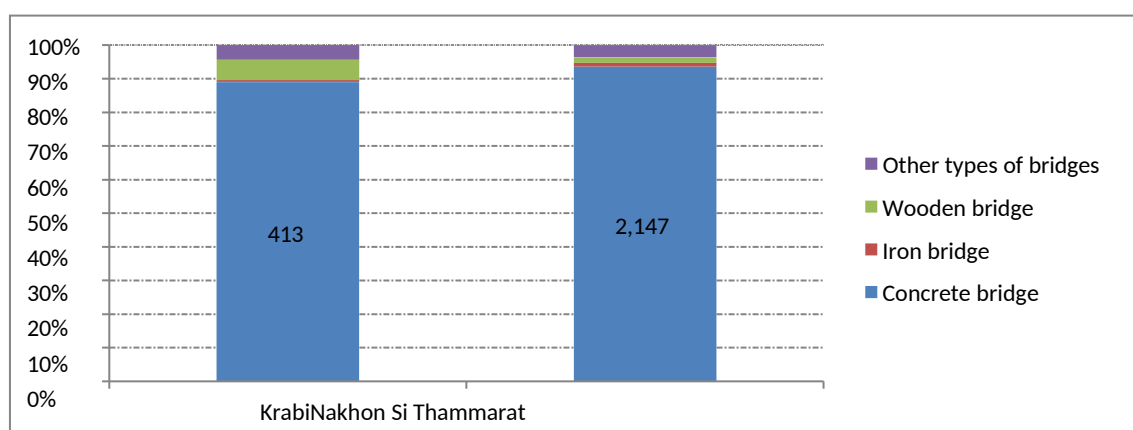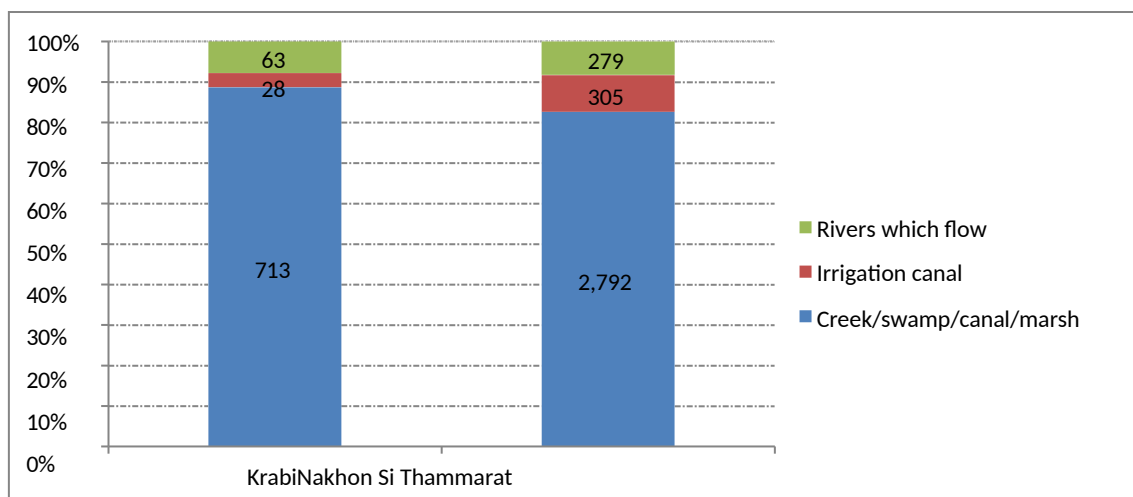

Figure 73: Types of available bridges
Source: Department of Local Administration, Ministry of Interior, 2018

## Types of irrigation systems available

As shown in
Figure 74, creek/swamp/canal/march form the basis of irrigation systems in both
Krabi and Nakhon Si Thammarat.

Figure 74: Types of irrigation systems in Krabi and Nakhon Si Thammarat provinces
Source: Department of Local Administration, Ministry of Interior, 2018

Potable water

Figure **75** shows that most households, at least 60% in both provinces have access to tapped water.
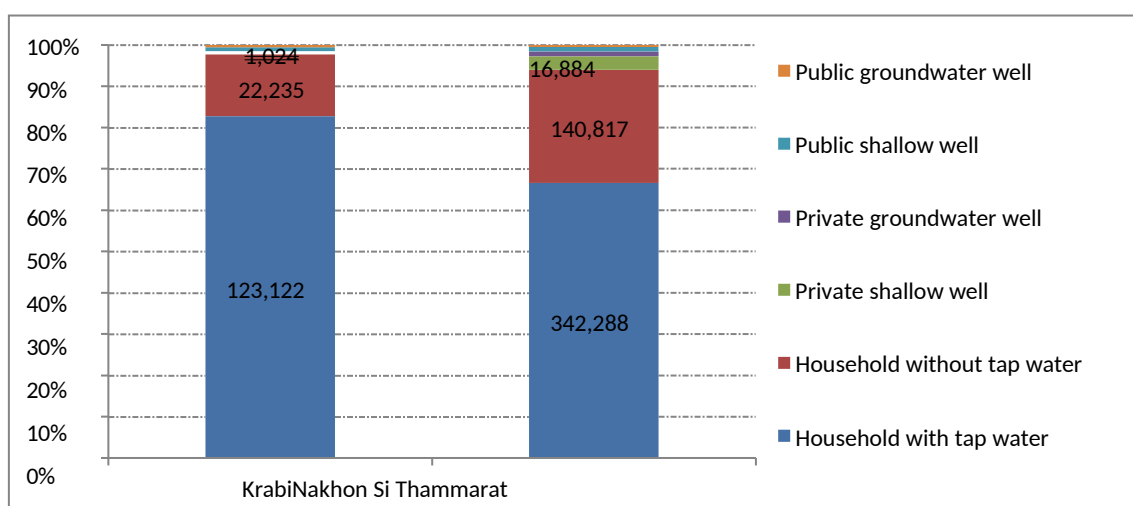
Figure 75: Available sources of portable water in Krabi and
Nakhon Si Thammarat provinces
Source: Krabi Provincial Office, 2018; Nakhon Si Thammarat Provincial Office,
2017

Electricity

As shown in
Figure **76**, less than 1 in 10 households in both provinces do not have access to electricity.
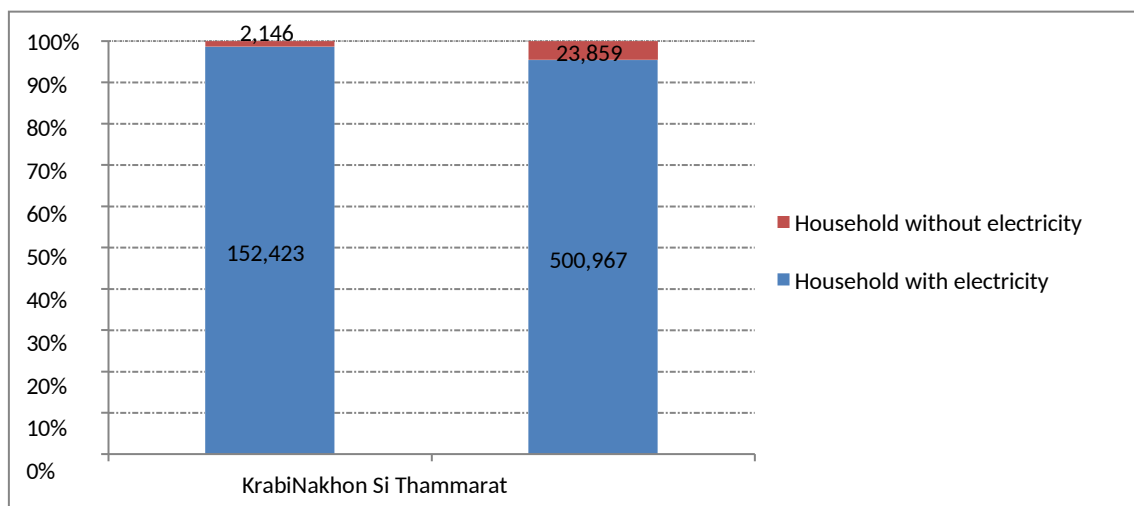
Figure 76: Households with access to electricity in Krabi
and Nakhon Si Thammarat provinces
Source: Krabi Provincial Office, 2017; Nakhon Si Thammarat Provincial Office,
2017