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Worsening Droughts and Coping Challenges of Rural Households in Chachoengsao Province, Thailand*

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Abstract

While typhoons and floods are highly visible, droughts are slow-onset disasters. As more prolonged dry seasons appear to be inevitable in South and Southeast Asia, it is important for the involved stakeholders to find solutions to freshwater shortages and associated livelihood challenges. This article discusses the findings of a questionnaire conducted among 370 households living in the most drought-prone sub-district in Chachoengsao Province, located along the Eastern Economic Corridor of Thailand. The results reveal that (1) coping strategies such as reducing water consumption and occupational diversification are insufficient, (2) monoculture farming exacerbates the situation, and 3) household status affect drought risks. Consequently, many households cannot cope adequately and current coping practices do not amount to long-term

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adaptive capacity. Households in our research area can get by and respond in the short-term to droughts and water scarcity, yet there is no comprehensive strategy to mitigate water scarcity in the sub-district. We propose four policy refinements that could contribute to a more effective strategy. These refinements are concerned with top-down policies, bottom-up initiatives, moving away from monoculture farming, and rethinking labour market strategies.

Key Words: livelihood trajectories, agriculture, household status, climate change, local governance, rural economy, Southeast Asia

Ⅰ. Introduction

Among the most threatening impacts of climate change in Southeast Asia are more frequent and intense droughts. While typhoons and floods are visible, short-term events which commonly receive much media attention, droughts have a slow-onset character, being less visible and under-reported. However, in the last three decades over 66 million people have been affected by droughts in Southeast Asia (UN-ESCAP 2020). As more prolonged dry seasons appear to be inevitable in South and Southeast Asia, it is important for the involved stakeholders to find solutions to freshwater shortages and associated livelihood challenges (Singh et al. 2014; Li et al. 2015; Díaz et al. 2019; Ebile et al. 2021).

Climate change exacerbates drought and water scarcity in Thailand. Likewise, the issue of water management along the Eastern Economic Corridor (EEC) is of crucial importance and needs better governance in order to reduce exposure to droughts and shortages in the coming

decades. age. On the hand, the EEC project generates a high demand for fresh water in the manufacturing, tourism, and residential sectors. On the other hand, nearby agricultural areas do not receive much attention from the national government. Unbalanced water management, then, could be the result. This article discusses the findings of a study in one of the provinces located along the EEC in Thailand, considered by the Thai government as an important geo-economic strategy corridor to achieve a high-income status through the promotion of high-tech manufacturing, transportation, and tourism (Theparat 2021; Bangkok Bank 2018). However, water shortages in this area have become a serious challenge for sustainable development. In particular manufacturing requires much water and consequently, there is a real threat that rural communities will increasingly face water shortages (Manorom 2020b). Furthermore, Water diversion from rural to urban areas is creating an increasingly unfair distribution of water resources. For instance, the Royal Irrigation Department (RID) has spent more than 15 million baht (US$480,000) supplying water to the EEC by building water storage systems and reclaiming more than 32,000 hectares of land. This has sparked tensions between rural communities and the state (OECD 2022). Thus, water availability in rural Chachoengsao is threatened not only by the impacts of climate change, but also by the imperatives of transforming the region into a core area of Thailand's geo-economy.

In light of the expected increasing water shortages, the aim of this study is to understand the situation and explore the patterns of coping at a community level. More specifically, we address the following

three research questions:

1. What are the major drought risk factors in Thung Phraya, the most drought-prone sub-district in Chachoengsao?
2. How do households in Thung Phraya cope with droughts and how are coping mechanisms shaped by household characteristics, status, and socio-economic profiles?
3. Based on the results, which policy measures could transform coping into long-term adaption culminating in reduced water scarcity and more inclusive development trajectories in the EEC?

The findings are based on spatial analyses related to drought in Chachoengsao (Figures 1-3) as well as a face-to-face questionnaire (following social distancing measures) among 370 households living in the Thung Phraya, conducted in June 2020 when Thailand was not yet significantly affected by the Covid-19 pandemic. After providing an overview of the conceptual-analytical context, this article presents the results and suggests policy recommendations.

Ⅱ. Drought risk and increasing water demand in Thailand

Drought phenomena in Southeast Asia are more likely to occur over longer periods of time, involving higher peak intensity, as well as higher levels of severity (Supharatid and Nafung 2021). Droughts are strongly associated with oceanic and atmospheric large-scale drivers, particularly the El Niño-Southern Oscillation (ENSO), followed by

other factors such as the variability of sea surface temperature (SST) over the tropical Atlantic, the Pacific decadal oscillation (PDO), and the Indian Ocean dipole mode (IOD). Phan-Van et al. (2022) found that there are significant differences between mainland Indochina and archipelagic Southeast Asia. According to the global climate risk index, during 2000-2019, Thailand was ranked the 9th most affected country by extreme weather events (German Watch 2021). Thailand's National Adaptation Plan (NAP) focuses on enhancing resilience and adaptation. However, at the provincial, district, and sub-district levels, the capacity to respond quickly and adequately right after a disaster is lacking. For example, in the Mun River Basin, risks are a combination of hazards, exposure, and vulnerability. Hazards will be more severe, culminating in lower agricultural yields. Communities and agricultural areas in the centre part of the basin are more exposed than others. Large areas are under high and moderate vulnerability due to low coping capacity (Prabnakorn et al. 2019). More than 70 percent of local people in northern Thailand reported drought and flood impacts on their livelihoods, but they do not completely understand its causes (Manandhar et al. 2015). Goodwin et al. (2022) found that droughts intensify agricultural and economic losses, environmental degradation, and the erosion of social cohesion. Therefore, building social networks and communication between stakeholders is essential. In a study of two projects in Nakhon si Thammarat Province, Southern Thailand, Singto et al. (2018) revealed that effective communication plays an important role when implementing community-based irrigation projects.

Another issue requiring more attention is drought monitoring.

Khampeera et al. (2017) introduced a technique using spatial and temporal data to construct a standard precipitation index (SPI), water table level (WTL), and standardized water level index (SWI). Those techniques were used to assess and monitor drought threats in the swampy areas of southern Thailand. In Northeastern Thailand droughts occur from a combination of natural factors and human activities rather than just a single natural cause. Spatial factors have also played a part. Research in this part of the country revealed that major factors are soil texture, soil fertility, and soil salinity (Wijitkosum 2018). Moreover, as local communities, farmers, and civil society organizations experienced water shortages, water governance has also become a controversial political issue involving discussions on distribution, equity, and access (Manorom 2020a). Overall, we can conclude that water management issues in Thailand have become increasingly complex (Baird et al. 2020).

Zooming in on the EEC, water demand will increase dramatically; not only for household consumption, industry, and tourism (Bangkok Bank 2018), but also for agriculture. This is partly due to limitations regarding irrigation techniques, water innovation as well as recycling. Chachoengsao Province is projected to be province with the highest water consumption in absolute terms. Chonburi Province and Rayong Province, both located on the EEC as well, are projected to face an increase in water demand by at least 50% until 2037. Land conflicts are also expected to increase because the revised city plans for the three provinces involve rural-to-industrial land conversion and enlarged industrial zones. Therefore, in addition to water issues, land conflicts and associated environmental and social challenges should

be investigated in the near future as well. The role of innovating planning will be crucial (Nation Thailand 2021).

Ⅲ. Investigating droughts in rural settings

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change clarified that there "is no more room for ambiguity: the climate is changing, and it's because of human activity. In every region of the world, climate extremes – heat waves, heavy precipitation, droughts, cyclones – are becoming more intense and more frequent" (IFAD 2021). What does this mean for rural communities and households engaged in agriculture and fishing? According to the International Fund for Agricultural Development (IFAD), rural communities worldwide will experience more crop failures, and heat waves and drought will affect farming, fishing, and herding. Overall, this will lead to higher food insecurity, and in the worst case, to climate migrants (World Bank 2021). This will increase the pressure on rural and urban areas receiving the migrants, reduce human capital in the left-behind areas, and cause heightened spatial disparities, potentially leading to social unrest. It is thus important to scrutinize the impact of weather extremes. The creation of preventive measures and reducing farmers' and fishers' debt levels are important measures to combat droughts (Sumadio et al. 2017; Thai PBS 2022).

Moreover, various types of household characteristics, such as gender and age of household heads, often play a major role in

households' ability to anticipate and reduce vulnerability. Gender is a determinant of the ability of households to adapt. For example, it can shape income adjustment and livelihood diversification when faced with prolonged droughts (Mehar et al. 2016). What also matter is how long households have lived in the community.

Within Southeast Asia as well, increased drought threats have received more attention although news on flooding are still more prevalent. Due to the severe droughts of 2015-2016 and 2018-2020, the UN Economic and Social Commission for Asia and the Pacific (UN-ESCAP 2020) has stressed the need to bring about more proactive rather than reactive policy responses. This is easier said than done as it is sometimes unclear which stakeholders should be the most proactive; droughts are not the only environmental threat, and rural diversity in terms of financial strength, educational attainment, and patterns of (seasonal) migration further complicate matters (Garbero and Muttarak 2013; Sakdapolrak et al. 2014).

In this article, we focus on Chachoengsao Province, located along the EEC, a relatively dry area in Thailand that is also experiencing water-related tensions between agriculture and manufacturing (UN-ESCAP 2020) [Figures 1a and 1b]. As introduced above, the national government envisions this corridor as one of the most important growth engines for Thailand's prosperity. These tensions are multi-dimensional: spatial (manufacturing in the more downstream areas, agriculture upstream), economic (poorer agriculture-based households versus middle classes in the towns), as well as political-administrative (the involvement of various government agencies in tackling droughts and associated disagreements).

The rationale for our empirical study can be summed up as follows:

1) Drought risk factors are often investigated by focusing on meteorological and hydrological factors (Tsakiris 2017), which can identify risk on a large scale (province or district) (Office of Nature Resources and Environmental Policy and Planning, Thailand). Nevertheless, this study aims to lay bare additional factors such as socio-economic factors which would better reflect risk at the local level (sub-district, community, and household level).
2) This study concentrates on water consumption among vulnerable rural households in addition to water for agricultural use. As such, this study provides a comprehensive understanding of water shortages.
3) Chachoengsao Province is the most drought-prone area of the EEC, and our study Site, the Thung Phraya sub-district, is the most drought-prone area in the entire province [Figures 1a, 1b, and 2].

Ⅳ. Data and Methodology

1. Study area

The Thung Phraya sub-district is located on a plateau and forms part of Sanam Chai Khet district. The sub-district consists of 19 villages (Figure 3). The total number of people is 16,563; 8,266 female, 8,331 males, and 5,015 households (Thung Phraya Tambon

Administration Organisation 2019). The climate is classified as hot and dry, especially during April when it can be extremely hot and dry. The soil types are mostly a combination of sand and rock, and organic, loose, and fertile soils are rarely found. Almost each village has a water resource, but Figure 2 shows that there are significant shortages. The Thung Phraya Tambon Administration Organization (TAO: the sub-district administrative council) has initiated projects aimed at increasing the water storage capacity such as by digging canals and improving ground water extraction. However, as will be elaborated below, drought risks remain and coping mechanisms are insufficient to stabilize and improve livelihoods. The majority of households make a living in agriculture growing rice, vegetables, fruits, and keeping livestock.

2. Sampling and data collection

This study used a multi-stage sampling technique to select survey locations and households. Thung Phraya was selected purposively due to its high intensity and high frequency of droughts (Figures 1a, 1b, and 2). The redundant drought areas during 2008-2017 or ten-year periods were covered. The GIS data employs the following classification of drought in agricultural lands: (a) no drought, (b) not more than three times within ten years, (c) 4-5 times within ten years, and (d) six or more times within 10 years (Thailand's Land Development Department 2018)

Based on the Taro Yamane formula, a sample size of 370 households was required in order to maintain a 95% confidence level

(Yamane 1967). Then, a probability proportional to size was applied to calculate the optimum number of households in each village. Next, the 370 households were selected using a simple random sampling from the population ratio in each village (Figure 3). A semi-structured questionnaire was used to collect data using face-to-face surveys conducted in June 2020. It comprised five sections ranging from household characteristics, drought experience, impacts of drought, coping strategies, to drought risk factors. At the beginning of the questionnaire, respondents were informed about the purpose of study and verbal consent was sought.

3. Variable selection and data analysis

The coping strategies were measured by enquiring about the actions that households took. We then analysed the answers and looked at priorities and actions (see also Pak-uthai and Faysse 2018). Therefore, the focus of this study was to fill the gaps regarding the differences between household characteristics in term of drought risk and vulnerability. The household drought risk was the dependent variable and comprised three factors: socio-economic, physical, and environmental. The mean score was derived from the Likert Scale (ranging from strongly disagree to strongly agree). The mean score was based on intervals as follows: 1.00-1.80 very low; 1.81-2.60 low; 2.61-3.40 medium; 3.41-4.20 high; and 4.21-5.00 very high (Table 4). The household characteristics were used as independent variables including gender, age, occupation, education, and income level of household head. The number of children (aged less than 12 years)

and elderly (aged over 60 years) were used as a proxy of population dependency in households (Table 1). The collected data from the questionnaires were coded and analysed using the statistical package for social sciences (SPSS). One-way ANOVA was used to examine which characteristics of the households influenced drought risk and vulnerability. In this study, Welch's ANOVA was employed to better detect variances since the number of samples in each sub-district was unequally distributed. Each factor was run as a series of Welch's ANOVA with the Games-Howell post hoc test. The most important tables are included in the article; other tables can be found in the online supplementary file.

Ⅴ. Results

1. Household characteristics

Table 1 shows that the gender of households' head is equally distributed. Generally, women play an important role in household management. In the single household type, female headed households (12.8) is more prevalent than male headed (4.7); East -West Population Institute 1987). The age of the household heads ranges from 17 to 82 years, with a mean age of 51.24 years. The age distribution among female household heads is concentrated within the 45-54 years group while male household heads tend to be older (concentrated within the at 55-64 group; 18.9 per cent). The average household size is three members. Almost 53 per cent of households

have no children, while 27.6 per cent and 13.8 per cent have only one child or two children, respectively. Families headed by women have fewer children than by men. Almost 55 per cent of households have no elderly member. Furthermore, the important occupations are in the field of agriculture and construction.

The majority of the respondents' educational attainment is in primary school (63.5 percent). This is quite low because most households are primarily engaged in agriculture, which implies a high demand for labour. Many people in the community are not well educated, and they have to engage in agriculture because it has been part of family tradition. As agriculture in rural Thailand still does not involve much high technology, manual labour remains in high demand. Nevertheless, high school graduates seek better opportunities outside agriculture. Women finished high school level much more frequently than men. Children having graduated from primary and high school do not participate in the agricultural or industrial sectors. They usually commute to work (not permanent migration). With respect to standards of living, most households have a low level of monthly income (91.1 percent), while 6.8 percent and 2.2 percent have a middle and high monthly income level (Table 1). The average household income in Chachoengsao Province is 22,875 Thai Baht per month (or 689 US, 1$=33.20). Generally, low incomes can be explained by households engaged in agriculture who are mainly renting land, who an average income about 9,627 Thai Baht or 290 USD per month (Chachoengsao Provincial Statistical Office 2020).

In sum, Table 1 reveals a worrying demographic profile of Thung Phraya. Most households work in agriculture, and their incomes and

educational levels are relatively low. These characteristics limit household coping mechanisms as will elaborated below.

2. The impact of drought and household coping strategies

This and the next sub-section address the first part of the second research question. Most respondents reported that they have experienced droughts (85.1 percent), while 9.2 percent reported that they have never faced it (Table 2). Around one quarter has faced other disasters such as wild elephant attacks, storms, floods, and pests. The rainfed areas in Thailand refer to the limited availability of water resources during dry seasons. Most affected areas lack irrigation projects and water management plans (Patsinghasanee 2020). The prioritisation of impacts reveals that the community perceives the effect of droughts to their occupation as very important, followed by livelihood, health, and others (Table 3).

Regarding the health impacts, women are more likely to perceive health impact from drought than men (female 52 percent while male 48 percent). And most people in this community have experienced heat strokes (1.6 percent), dust, food poisoning, a lack of clean water for bathing (14.8 percent), or social problems. The coping strategies were examined by asking about the actions taken during previous drought situations. The households were also asked to prioritise activities (Table 3). The results reveal that reducing water consumption coupled with changing water use behaviour had the highest priority.

3. Drought risk factors in Thung Phraya

Overall, Table 1s indicates that the level of risk in Thung Phraya is classified as high (see the online supplementary file for Tables 1s-5s). Considering the factors causing communities to be at risk and vulnerable, it was found that the main factors were physical and environmental (=3.72, S.D.=1.05). The shortage of rainfall and dry spells lasting for prolonged periods (=4.27, S.D.=0.90), followed by a high rate of evaporation (=3.93, S.D.=0.93) placed the community at a high level of risk (Table 4). Socio-economic factors (=3.68, S.D.=1.06) lead to a high level of drought risk because most households are engaged in agriculture which largely depended on water for cultivating crops (=4.19, S.D.=0.86; Table 4). The agricultural policy has focused on single or monoculture farming crops such as rice, maize, rubber, casava, and sugarcane, which has led to an even higher demand for water (=3.83, S.D.=0.86). Other factors can be considered as posing a moderate risk (=2.96, S.D.=1.35) such as delayed regulation, budget approval, and land expropriation which have created more community problems (=3.83, S.D.=0.92; Table 4). In sum, Thung Phraya has a high level of drought risk as a result of rainfall deficits, a higher demand for water, and socio-agricultural factors that hamper adequate coping.

4. Differences in household status and drought risk

This section elaborates on the differences in the status of

households. It answers the second part of the second research question. The age of household heads has a significant influence on drought risk, vulnerability, and adaptation. The mean drought risk related to physical and environmental factors differed significantly among the age of the household heads, FWelch (4,95.915)=2.616, p=0.040 (Table 2s). The age groups with significant differences (p value < 0.10) comprised the household heads aged younger than 31 years and aged 61 years and older (Table 3s).

Occupation also turned out be significant (FWelch [5,24.014] =3.013, p=0.030; Table 2s), particularly with respect to the household heads who were unemployed or who worked as a seller (p value < 0.10; Table 4s). Villagers without a decent full-time job have a limited income and healthcare costs may contribute to vulnerability by slowing the community recovery process. In addition, many people work in the informal sector. Based on our results, unemployed household heads are at risk of socio-economic factors. They have limited opportunities to access formal insurance or security as their characteristic of job comparing to government officer and private company staff. They may not have proper social welfare documentation and they may not qualify for or even seek government support in normal times. As such, they are often not registered with social protection programs. They tend to depend on less formal financial services providers (FSPs). The number of children in households is also significantly related to socio-economic factors (FWelch (3,74.557) =2.161, p=0.100; Table 2s). Peek et al. (2017) explained that children have been recognised as a potentially vulnerable population. They are embedded in a number of caretaking

relationships within families, peer groups, schools, and other organizations and institutions in their lives that may either buffer or exacerbate the effects of disasters.

Table 2s shows that the household heads who had a community position (=3.00) had a higher mean drought risk and vulnerability (=2.87). Therefore, the drought risk and vulnerability for other factors were significantly different ($p<0.05$) between the heads of households who held a position in the community and those who did not. This is because household heads with leadership positions may have a high level of risk awareness and perception. As a result, they understand and identified causes of drought risk and vulnerability in more detail.

Ⅵ. Discussion, conclusions, and recommendations

The transformation of agriculture from subsistence to a market production system has had profound implications for risk exposure and rural governance. Thai farmers are known for their widespread use pesticides to as a way to increase yields. However, this increases environmental risks for rural communities. Since the inception of the First National Economic and Social Development Plan in 1961, agriculture was deliberately planned by the Thai Government until at least 1976 to generate the foreign exchange earnings needed to stimulate industrial development. As part of this push, monoculture farming was introduced to replace the traditional practice of self-sufficient farming while domestic prices were kept at low levels to keep labour costs low and stimulate industrial development

(Puntasen and Preedasak 1998). We have also observed the frequent practice of monoculture farming. In addition, there are also health risks. According to a World Health Organisation (WHO) estimate, rapidly increasing emissions have led Thai people to be more exposed to health risks due to climate change. Based on long-term projections, approximately 9.2 percent of Thai children could face malnutrition (WHO 2015). In Thung Phraya many households also worry about the higher frequency of droughts (Table 2).

In terms of responses to drought, we observed a haphazard patchwork of activities rather than a comprehensive, proactive strategy to address water shortages (Table 3). There are areas in Thailand with somewhat better experiences and strategies (e.g. Khongdee et al. 2021), but overall it appears that more could be done, particularly in light of future projected weather extremes (UN-ESCAP 2020). Völker et al. (2011) found that farmers adjusted their income portfolio by engaging in off-farm employment and increasing their savings by using their buffer stocks, such as the storage of food and seeds. They also keep savings accounts for collective action and investment activities. A few households resorted to outmigration. Meanwhile, Thailand's Department of Disaster Prevention and Mitigation (DDPM) emphasizes drought relief measures for the affected populations, for example, by sending water trucks to drought-affected villages, producing artificial rain, and utilizing underground water sources. Households also resorted to bottom-up self-support strategies by looking for equipment to store water in households. However, these coping strategies appear to be insufficient (Table 3). Pak-uthai and Faysse (2018) suggested that coping actions

merely have short-term effects whilst an adaptive action was planned and involved long-term positive changes. Coping actions can reduce the impact of droughts but does not necessarily decrease vulnerability.

Another interesting of our empirical inquiry is that age is more significant than gender. Older people are among the most at risk of decreased mobility and at times, face restricted access to resources, all of which may limit their coping mechanisms (Filiberto et al. 2008). In contrast, Miller et al. (1999) argue that older adults were less vulnerable than their younger people due to their experience and knowledge of the community and immediate surroundings. Muttarak and Lutz (2014) suggested that education is very important as it can directly increase risk perception, skills, and knowledge, and indirectly reduce poverty, improve health, and promote access to information and resources. When faced with drought risks, people and households with educational backgrounds are expected to be more empowered. Gender was found to be insignificant to drought risk and vulnerability in rural Thai society. These results contradict experiences in other countries of the Global South where men find it easier to adapt or change than women because women have limited access to socio-economic and political resources and enjoy a lower status (Shabib and Khan 2014; Mehar et al. 2016). The results from our empirical inquiry demonstrate that age, occupation, number of children, and educational attainment are more important than gender. Follow-up research is needed to find out whether this is a clear-cut result or whether gender plays an indirect role through other mechanisms.

Overall, our results reveal that (1) coping strategies such as

reducing water consumption and occupational diversification are insufficient, (2) monoculture farming exacerbates the situation, and 3) household status affect drought risks. The coping mechanisms revealed in this study demonstrate that more needs to be done. Current coping does not amount to long-term adaptive capacity. Households in Thung Phraya can get by and respond in the short-term to droughts and water scarcity, yet there is no effective comprehensive strategy to mitigate water scarcity in the sub-district and indeed the province of Chachoengsao. If nothing progresses, the aim of transforming this province as well as the wider EEC into an inclusive corridor remains elusive.

Based on these findings, we now answer the third research question: which policy measures could transform coping into long-term adaption culminating in reduced water scarcity and more inclusive development trajectories in the EEC? Below we propose four policy refinements that could contribute to a more effective strategy. First, from a top-down perspective, the possible measures for drought risk management in communities include drought risk mapping, setting up public ponds, and expanding the availability of free tap water posts (Bangkok Post 2023a). Policymakers could also consider the current contributing limitations such as delays in legal processes, a lack of integration between various agencies, and a lack of innovation in water management (Faiyue et al. 2021).

Second, from a more bottom-up perspective, we suggest the improvement of the Community Based-Disaster Risk Management (CBDRM) program which aims to strengthen and enhance the capacity of the community to deal with droughts. This should also

include strengthening inter-generational conversations since we found that younger and older households are particularly vulnerable to droughts Habiba et al. (2012) also wrote that "the middle-aged farmers are likely to be more active in applying farming experiences better in any adverse environment." Relatively successful farmers in the middle-aged group should be encouraged to take up (informal) leadership positions and disseminate their knowledge and practices to younger and older households. The findings of this research have been used in a follow-up study focusing on improving communication and community resilience. A community participation approach to deal with drought has been carried out investigating how villages' capacities can be strengthened by employing a CBDRM program including a gaming simulation tool (see also Tanwattana and Toyoda 2018 and Tanwattana 2021 for the case of flooding in Thailand).

Third, we found that a key driver of the high demand for water is monoculture farming. It is imperative that rural communities move away from monocultures and transform existing patterns of land use to more intercropping and ideally, also agroforestry. This would require less water, improve water levels, and restore biodiversity. Agencies under the Ministry of Agriculture could support communities with this transformation. It would also reduce socio-economic risks as the dependence on a single crop decreases. Knowledge management of community innovations for drought resilience forms an important component for achieving this objective and moving on from short-term coping to long-term adaptation (Faiyue et al. 2021).

Finally, EEC policymakers should rethink labour market strategies and the consequences of rural-urban migration (Channel News Asia

2023). The Covid-19 pandemic, as well as the continuing presence of informal jobs, demonstrate that jobs in the informal sector are (1) insecure and (2) insufficient to support rural communities. The informal sector does not offer a decent diversification strategy and, ultimately, a way to reduce pressure on rural areas including the demand for fresh water. Without addressing these socio-spatial and socioeconomic considerations, the EEC might only become a success for the upper classes (Manorom 2020b). This would jeopardise Thailand's strategy to escape the middle-income trap as well as offer more opportunities for younger generations to enter the middle class and support ageing relatives in the countryside.

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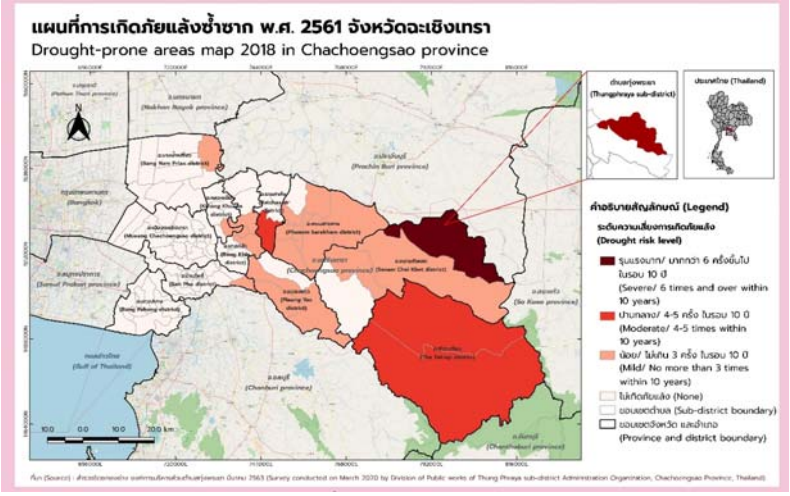
Figures and Tables

Figures 1a and 1b: Drought risk areas in Chachoengsao Province and the Eastern Economic Corridor of Thailand. Source: Compiled by the author from the Land Development Department, Thailand



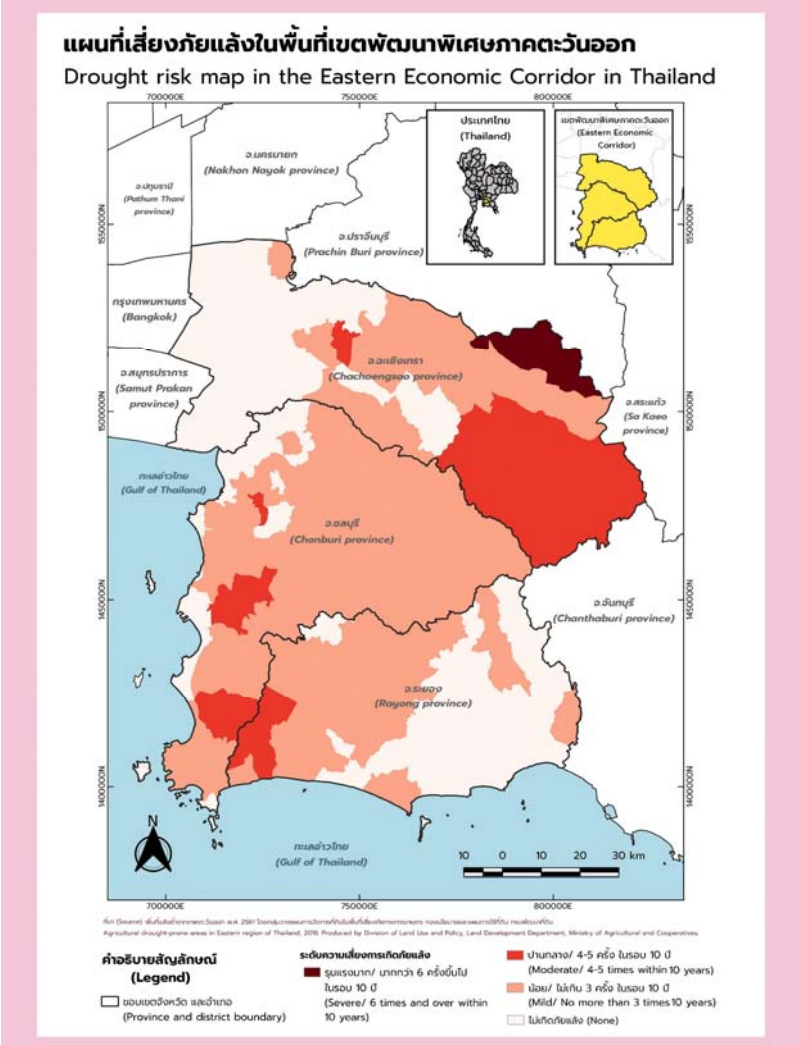

แผนที่เสี่ยงภัยแล้งในพื้นที่เขตพัฒนาพิเศษภาคตะวันออก
Drought risk map in the Eastern Economic Corridor in Thailand
700000E
750000E
800000E
1550000N
1500000N
1450000N
1400000N
ประเทศไทย
(Thailand)
เขตพัฒนาพิเศษภาคตะวันออก
(Eastern Economic Corridor)
จ.นครนายก
(Nakhon Nayok province)
จ.ปทุมธานี
(Pathum Thani province)
จ.ปราจีนบุรี
(Prachin Buri province)
กรุงเทพมหานคร
(Bangkok)
จ.สมุทรปราการ
(Samut Prakan province)
จ.ฉะเชิงเทรา
(Chachoengsao province)
จ.สระแก้ว
(Sa Kaeo province)
ทะเลอ่าวไทย
(Gulf of Thailand)
จ.ชลบุรี
(Chonburi province)
จ.จันทบุรี
(Chanthaburi province)
จ.ระยอง
(Rayong province)
N
10 0 10 20 30 km
คำอธิบายสัญลักษณ์
(Legend)
ขอบเขตจังหวัด และอำเภอ
(Province and district boundary)
ระดับความเสี่ยงการเกิดภัยแล้ง
รุนแรงมาก/ มากกว่า 6 ครั้งขึ้นไป ในรอบ 10 ปี
(Severe/ 6 times and over within 10 years)
ปานกลาง/ 4-5 ครั้ง ในรอบ 10 ปี
(Moderate/ 4-5 times within 10 years)
น้อย/ ไม่เกิน 3 ครั้ง ในรอบ 10 ปี
(Mild/ No more than 3 times 10 years)
ไม่เกิดภัยแล้ง (None)

Figure 2: Drought risk situation in the Thung Phraya sub-district, Chachoengsao Province. Source: Compiled by the author from the Division of Public Works of the Thung Phraya sub-district Administration Organisation, Chachoengsao Province, Thailand.

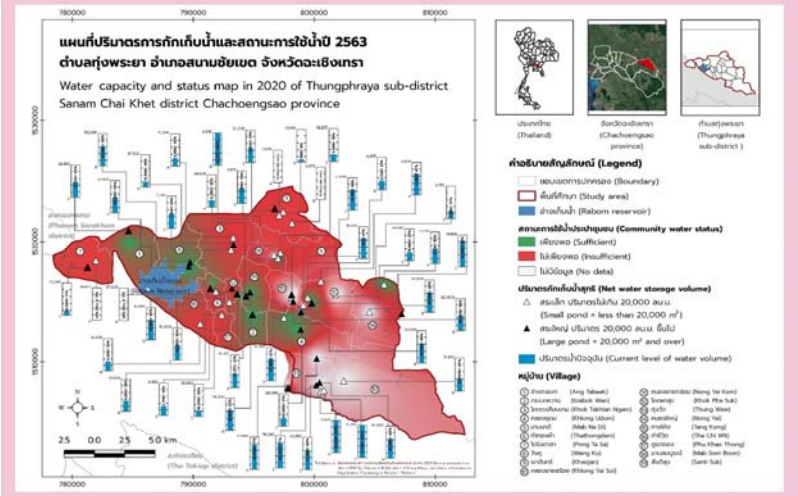


Figure 3: Data distribution of research sampling size: Household map of the Thung Phraya sub-district, Chachoengsao Province. Source: Compiled by author from population data in 2019 from the Public Health Office, Chachoengsao Province, Thailand.

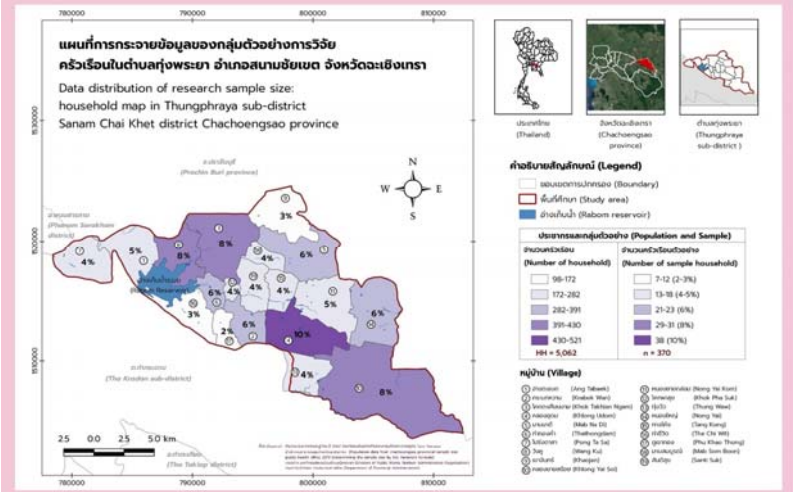


Table 1: Demographic characteristic of household's respondents

Demographics	Total (n = 370) Frequency	%
Gender of household head		
Female	183	49.5
Male	187	50.5
Age of household head	Mean = 51.24	
Less than 31 years	21	5.7
31-40 years	40	10.8
41-50 years	95	25.7
51-60 years	144	38.9
61+ years	70	18.9
Size of household	Mean = 4.36	
Single (stay alone)	11	3.0
Small (2 members)	39	10.5
Large (3 members and over)	320	86.5
Number of children (age below 12 years)		
No children	195	52.7
1 child	102	27.6
2 children	51	13.8
3+ children	22	5.9
Number of elderlies (age above 60 years)		
No elderly	203	54.9
1 elderly	119	32.2
2 elderlies	46	12.4
3+ elderlies	2	0.5
Occupation of household head		
Public sector	6	1.6
Private sector	11	3.0
Contractor	86	23.2
Seller	30	8.1
Agriculture	230	62.2
Unemployed	7	1.9
Education of household head		
Primary school	235	63.5
Junior high school	91	24.6
Senior high school	33	8.9
Bachelor's degree	8	2.2
No education	3	0.8
Monthly income of household (1 THB=0.031$ USD)		
Less than 10,001 THB	176	47.6
10,001-20,000 THB	161	43.5
20,001-30,000 THB	23	6.2

30,001-40,000 THB	2	0.5
40,001-50,000 THB	2	0.5
50,001+ THB	6	1.6
Position in community of household head		
Yes	173	46.8
No	197	53.2

Table 2: The household's drought experience

Variables	Total (n=370)	
	Frequency	%
Drought experience		
Yes	315	85.1
No	34	9.2
Often	21	5.7
Experience to other disasters		
Yes	89	24.1
No	281	75.9
Did the drought's impacts gradually increase to your households?		
Yes	252	68.1
No	76	20.5
Not sure	42	11.4
Did the coping strategies sufficient to deal with drought situation?		
Insufficient	183	49.5
Sufficient	146	39.5
Not sure	41	11.1

Table 3: Prioritization of drought's impacts and coping strategy

Variables	Priority						No answer
	1	2	3	4	5	6	
Impacts of drought							
-Everyday life	141	170	21	0	-	-	38
-Occupation	208	137	7	0	-	-	18
-Health	17	12	177	1	-	-	163
-Others	2	0	4	31	-	-	333
Coping strategies (previously)							
-Reduce of water use and changing behaviour for water consumption	140	85	33	17	0	0	74
-Jobs diversification	60	93	93	31	14	0	79
-Asking for support from agency	43	56	75	43	31	0	122
-Groups of water user formation and networking	27	64	25	44	22	0	188

-Looking for some equipment to store water in households	96	43	49	22	25	0	135
-Others	2	0	1	0	0	22	345
Further solution for drought risk management in community							
-Manipulating drought risk and vulnerability maps for the community's water management	144	72	119	0	-	-	35
-Selection of suitable area for water management in community	100	169	79	0	-	-	22
-Increasing the capacity of water storage	124	106	113	0	-	-	27
-Others	2	1	1	34	-	-	332

Table 4: Drought risk sub-factors

Drought risk factors	Total (n = 370)			
	$\bar{X}$	S.D.	% Not sure	Interpretation
1.Socio-economic factor				
1.1 lack of coordination of water management among the up-stream middle stream and down stream	3.75	0.99	3.5	High
1.2 the agricultural livelihood depends on a lot of water for cultivation	4.19	0.86	1.4	High
1.3 policy on monoculture demand a lot of water	3.83	0.86	2.2	High
1.4 Continuing rapid population growth in EEC because of labour migration resulting for increase of water demand	3.24	1.16	1.4	Medium
1.5 unbalancing between the higher demand of water in industrial sector more than agricultural sector.	3.38	1.13	11.4	High
Total	**3.68**	**1.06**	**19.9**	**High**
2. physical and environmental factor				
2.1 the amount of rain decreases and dry spell occurring for a very long period.	4.27	0.90	0	Very high
2.2 evaporation rate is higher than the amount of rain falls	3.93	0.93	1.4	High
2.3 lacking the coordination of systematic water management and lack of water storage in rainy season	3.70	1.00	2.7	High
2.4 Improper Land use zoning	3.35	1.04	2.2	Medium
2.5 the improper terrain for building the water storage	3.65	1.05	2.4	High
2.6 the quality of water unsuitable for consume.	3.41	1.06	0.3	High
Total	**3.72**	**1.05**	**9**	**High**

3. Other factors				
3.1 delay process of laws and regulation, budget approval, expropriate of land, which could not immediately solve the community's problems	3.83	0.92	2.7	High
3.2 lack of coordination among stakeholders and related organizations	3.58	0.95	3.0	High
3.3 limited in knowledge innovations, and lack of integration for water management among stakeholders to conduct short-term and long-term disaster preparedness and response plan	1.51	0.66	0	Very low
Total	**2.96**	**1.35**	**5.7**	**Medium**

Tables for the online supplementary file

Table 1s: Drought risk factors

Drought risk factors	Total (n = 370)			
	$\overline{X}$	S.D.	% Not sure	Interpretation
-Socio-economic factors	3.68	1.06	19.9	High
-Physical and environmental factors	3.72	1.05	9.0	High
-Other factors	2.96	1.35	5.7	Moderate
Total	**3.54**	**1.16**	**34.6**	**High**

Table 2s: Welch's ANOVA

Variable	Socio-economic	Physical and Environmental	Others
HH head is female	3.65	3.70	2.88
HH head is male	3.66	3.72	2.97
t-value	*0.902*	*0.680*	*0.191*
Sig.	*ns*	*ns*	*ns*
HH head age: < 31 years	3.74	3.94	3.16
HH head age: 31-40 years	3.75	3.86	2.83
HH head age: 41-50 years	3.69	3.74	2.96
HH head age: 51-60 years	3.66	3.69	2.93
HH head age: 61+ years	3.50	3.56	2.87
F-ratio	*1.56*	*2.616*	*1.207*
Sig.	*ns*	*0.040**	*ns*

Single household's size	3.24	3.65	2.97
Small household's size	3.59	3.62	2.64
Large household's size	3.67	3.72	2.96
F-ratio	*1.478*	*0.512*	*3.475*
Sig.	*ns*	*ns*	*0.049**
No children in HH	3.62	3.70	2.92
1 child in HH	3.78	3.77	2.98
2 children in HH	3.48	3.58	2.88
3+ children in HH	3.73	3.84	2.88
F-ratio	*2.161*	*1.510*	*0.363*
Sig.	*0.100***	*ns*	*ns*
No elderly in HH	3.66	3.73	2.95
1 elderly in HH	3.63	3.68	2.90
2 elderlies in HH	3.63	3.68	2.91
3+ elderlies in HH	4.20	3.92	3.00
F-ratio	*0.283*	*0.216*	*0.100*
Sig.	*ns*	*ns*	*ns*
HH head work in public sector	3.60	3.25	2.61
HH head work in private sector	3.99	4.02	2.83
HH head work in contractor	3.65	3.69	3.00
HH head work in seller	3.46	3.57	2.69
HH head work in agriculture	3.66	3.72	2.95
HH head unemployed	3.80	4.21	2.86
F-ratio	*0.664*	*3.013*	*1.225*
Sig.	*ns*	*0.030**	*ns*
HH head had primary school	3.63	3.67	2.94
HH head had junior high school	3.64	3.78	2.85
HH head had senior high school	3.95	3.86	3.07
HH head had bachelor's degree	3.53	3.75	2.83
HH head had no education	2.93	3.28	3.11
F-ratio	*7.600*	*2.041*	*0.779*
Sig.	*0.002**	*ns*	*ns*
HH had low-income level	3.62	3.71	2.91
HH had middle-income level	3.96	3.71	3.07
HH had high-income level	3.93	3.83	3.04
F-ratio	*8.761*	*0.477*	*1.023*
Sig.	*0.002**	*ns*	*ns*

HH head had position	3.72	3.68	3.00
HH head had no position	3.70	3.62	2.87
t-value	*0.278*	*0.848*	*1.991*
Sig.	*ns*	*ns*	*0.047**

Notes: ns = non-significant, * = significant at the 0.05 level, ** = significant at the 0.10 level, HH = household, F-ratio = Welch

Table 3s: differences in age group of household's head on mean drought risk in physical and environmental factor

Age group	Less than 31 years	31-40 years	41-50 years	51-60 years	61+ years
Less than 31 years	-	0.08903	0.20655	0.25370	0.38254**
31-40 years		-	0.11752	0.16468	0.29351
41-50 years			-	0.04715	0.17599
51-60 years				-	0.12884
61+ years					-

**p < .10

Table 4s: differences in occupation of household's head on mean drought risk in physical and environmental factor

Occupation	Public sector	Private sector	Contractor	Seller	Agriculture	Unemployed
Public sector	-	-0.76515	-0.44438	-0.32333	-0.46681	-0.96429
Private sector		-	0.32077	0.44182	0.29834	-0.19913
Contractor			-	0.12105	-0.2243	-0.51991
Seller				-	-0.14348	-0.64095**
Agriculture					-	-0.49747
Unemployed						-

**p < .10

<국문초록>

태국 차층사오 주 농촌 가구의 가뭄 악화와 대처 방안

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태풍과 홍수는 그 피해 규모를 측정할 수 있는 반면, 가뭄은 긴 기간동안 피해를 서서히 발생시키는 특징을 가지고 있다. 남아시아와 동남아시아에서 건기가 더 길어질 것으로 전망하는 만큼, 관련 이해관계자들이 담수 부족과 관련된 생계 문제에 대한 해결책을 찾는 것이 중요하다. 본 논문은 이를 확인하고자 태국 동부경제구역을 따라 위치한 차청사오성에서 가장 가뭄이 잦은 지역에 거주하는 370 가구를 대상으로 실시한 설문조사 결과를 논의한다. 설문 조사 결과 단일재배 농업이 상황을 악화시키고 있었으며, 가구의 경제수준이 가뭄 위험에 영향을 미친다는 것을 파악할 수 있었으며, 물 소비를 줄이고 및 간작을 통한 생물 다양성을 증진시키는것과 같은 대처 전략이 미비하였다. 현재 많은 가구가 적절한 대처를 못하고 있는 상황이며 장기적인 해결 방안이 되기엔 부족한 실정이다. 연구 대상지들은 가뭄과 물 부족을 단기적으로 극복하고 대응할 수 있으나 장기적인 측면에서 보았을 때, 물 부족을 완화하기 위한 포괄적인 전략은 없다. 이에 따라 본 연구는 더 효과적인 전략에 기여할 수 있는 네

가지 정책 개선을 제안한다. 이는 하향식 정책, 상향식 이니셔티브, 단일 재배 농업 의존도 감소, 그리고 노동시장의 개편이다.

주제어: 생계 궤적, 농업, 가구 현황, 기후 변화, 지방 거버넌스, 농촌 경제, 동남아시아