Perceptions of climate change and associated health impacts among communities in Johor River Basin, Malaysia

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ABSTRACT

Introduction: As climate change is threatening every region of the world, extreme weather events resultant of global warming is occurring at increasing rate and scale in Malaysia. Weather-related disasters such as flood and haze pose critical challenges to the infrastructure and raise public health concerns in the country, especially when main economic sectors rely heavily on climate variability. Public perception on environmental issues is crucial for development of pro-environmental policies. Among studies conducted to understand public awareness regarding global warming, reports of perception on the health impacts were very limited. Taking this limitation into account, this study was designed to examine the perception on the health impacts of climate change among the diverse communities living in the Johor River Basin.

Materials and Methods: The cross-sectional study was conducted through cloud-data-based digital questionnaires completed by randomly selected residents in the Johor River Basin (n=647). Data was analysed with descriptive statistics using SPSS 27 (IBM®) Software. Comparisons between indigenous and non-indigenous communities were performed using Chi square analysis.

Results: Respondents in this study consisted of indigenous people (n=79) and non-indigenous people (n=568). Indigenous respondents generally perceived more frequent occurrence of extreme weather events in the next 20 years, even for the phenomena unfamiliar in Malaysian settings. All respondents showed similar concerns for health impacts of global warming, although the non-indigenous respondents perceived the risk further into the future (25 years) compared to the indigenous respondents who perceived current or imminent (<10 years) risks. Intense concerns for self, children, family members and community were shown by nearly all indigenous respondents (97-99%), while the non-indigenous people in this study expressed stronger concerns at country level and for future generations. During the last haze episode, most indigenous respondents (85%) did not notice any change in air quality nor discomfort among family members, in contrast 70% of the non-indigenous respondents claimed to have suffered from breathing problems themselves as well as others in the family. All respondents were concerned about air quality in their surroundings, indigenous people were concerned for the near future (<10 years), and non-indigenous people were concerned for the next 25 years.

Conclusion: In this study, respondents were generally concerned about the health impacts of unimpeded global warming. There was significant difference in perceptions between indigenous and non-indigenous respondents. The findings were useful, complemented with further studies, to improve understanding of public awareness and to help develop relevant education programmes accessible for wider audience.

KEYWORDS:
Public perception, climate change, global warming, indigenous community, public welfare

INTRODUCTION

Climate change is the most critical environmental challenge faced by every region across the world, and it's increasingly associated with anthropogenic causes. Global warming, as the paramount issue, is happening in an unprecedented rate due to emission of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) reported more intense extreme weather events including heat waves, heavy precipitation, drought and rising sea levels, amid projecting global warming to exceed 1.5°C within this century.[1] In Malaysia, climate change has been observed through increase in extreme weather events such as precipitation, cyclones and heat waves,[2-5] while modelling and simulation speculating such events to occur more frequently and in bigger scale.[6,7]

The impact of unpredictable and recurrent extreme weather events could devastate the country as it threatens the basic requirements for public's wellbeing including freshwater, clean air, food security, shelter and sanitation facilities.[8] Malaysia has long coastline, therefore coastal flooding is regarded as major hydrological disaster affecting hundreds of thousands of victims and damage of high-valued infrastructure, causing prolonged disruption of livelihood, socio-economic activities and sustainability of coastal communities, especially in densely populated and economically developed states such as Selangor and Johor.[9-11] Apart from psychological stress resulting from displacement, floods and the resulting pollution to water supply system have also been associated with various infections that are bacterial, viral, parasitic and zoonotic infections.[12,13] In Malaysia, coastal erosion, greenhouse effects, deforestation, inundation following heavy precipitation and pollution are also vital environmental and public health concerns.[14-16] For

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instance, vegetation fires caused by controversial farming method have resulted in transboundary haze problem in Malaysia. Apart from short term disturbance to the respiratory system and worsening of asthma, exposure to repeating haze episodes had also been found to associate with lasting effect on victims' psychology, respiratory-cardiovascular systems, neurological morbidity and mortality.[17]

Agriculture industries, including fisheries, are important economic contributors in Malaysia, especially for communities living in the vicinity of freshwater sources such as river.[18] However, as agriculture relies highly on weather stability, the livelihoods of associated workers are therefore confronted by global warming and changing climate. Unpredictable weather pattern has reduced crops,[19] elevated occupational risk and increased uncertainties during harvesting operations.[18] Siwar et. al. had presented the risk of changing climate towards agricultural sustainability in Malaysia, especially for those struggling on poverty line,[20] as global warming spikes price of daily necessities. Previous study had echoed that particular subpopulations such as elderly, children, pregnant women, malnourished, chronic disease patients, physically or mentally impaired, outdoor workers and residents of flood-prone areas, were disproportionately affected by the impacts of changing climate,[21] and oftentimes underrepresented in the South-East Asia (SEA) region.[22] Implementation of mitigation policies might also face economic and social barriers that reduce efficacy and specificity towards the most vulnerable subpopulations.[23,24]

Citizen's perception and awareness towards their surroundings and environmental issues are crucial for behaviour changes and is the driving force for pro-environmental policies and decision making.[25] However, current environmental education for general public is still lacking in distribution of delivery and there is need for a more specific approach, especially for younger generations in schools.[26] Another popular source of information is media, but locally relevant climate issues might be overshadowed by Western perceptions of the problem and reporting maybe biased towards countries where westerners have political interest.[27] To close the gap between public awareness and decision making related to global warming, studies had been conducted to understand people's perception, knowledge and behavioural adaptation in Malaysia. However, representation and experiences of minority groups such as the indigenous communities were inadequately addressed in these studies, especially in Peninsular Malaysia.[28,29] With the aim of contributing to existing literature, this study examined the perception on the health impacts of climate change and global warming among the diverse communities residing in the Johor River Basin.

MATERIALS AND METHODS

In this cross-sectional study, the survey questionnaire methodology was employed to better understand the prevalence between demographics and perceptions on health impacts of climate change. The first section of the questionnaire aimed to collect information on the demographics of the respondents. The subsequent section regarding perceptions on climate change and health was adapted from Akerloft et. al., study conducted in Northern America and Malta from 2008 to 2009.[30] The last section regarding air quality was adapted from similar study in China.[31] Following ethical approval, informed consent and permission from respective village heads, this study was conducted between October 2021 and June 2022 among communities residing around Johor River Basin. The broader geographical location covered with questionnaires (Figure 1) consisted of communities living in oil palm plantations irrigated by Johor River and its tributaries. Data collectors were appointed by village heads to gather responses from the community members on the ARCGIS™ platform, where the coordinates of the location of respondents could be recorded. From each household, one representative capable of communicating in the Malay language, and agreed to participation, was recruited as respondent. Incomplete responses to the questionnaire were excluded. Data was uploaded anonymously to a secure cloud database. Data collectors visited respondents in their households and digital questionnaires via electronic tablets were used to prevent prolonged contact of non-local personnels with the vulnerable communities as the study was conducted in the latter part of the COVID-19 pandemic. Data collectors were encouraged to collect responses at different times of the day and obtain a gender-balanced pool of respondents.

A power calculation in this study was undertaken using G* Power software®. A priori data analysis was undertaken comparing two independent groups (two tailed; effect size = 0.5; α error probability = 0.05; power = 0.95) and found that the minimal sample size to detect a medium effect size would be 105 participants in each sample group.

Collected data from the questionnaires was analysed with descriptive statistics using SPSS 27 (IBM®) Software. Comparisons between indigenous and non-indigenous respondents were performed using Chi square analysis.

RESULTS

Demographics

Among the 647 respondents in this study (Table I), 79 were Orang Asli, (indigenous people) for the remaining of this article. The majority of respondents (n=568) were non-indigenous, comprising Malay (n=564), Chinese (n=2) and others (n=2). The indigenous respondents were significantly younger in this study, than the non-indigenous respondents ($p<0.001$), with 64% (n=50) aged between 17 and 35 years old, and 60% of the non-indigenous respondents were aged between 24 and 55 years old. There were more male respondents among the indigenous people (56%, n=44), but the non-indigenous respondents were more evenly distributed (51% female, 45% male, and 5% preferred not to say).

During the analysis of data from this study, the authors observed a consistent trend where respondents from the indigenous cohort perceived climate change and the relevant human health impacts in significantly different way than those from the non-indigenous cohort. Hence the authors believed comparison between the two cohorts would best

Table I: Respondent demographics and comparison between indigenous and non-indigenous communities.

	Indigenous		Non-indigenous		statistic	df	p-value
	n	%	n	%			
Respondent (n)	79	100	568	100			
Gender					$c^2 = 4.36$	2	0.113
Male	44	56	255	45			
Female	34	43	287	51			
Prefer not to say	1	1	26	5			
Age group					$c^2 = 29.59$	5	< 0.001**
18 – 24	17	22	105	18			
25 – 34	33	42	124	22			
35 – 44	19	24	104	18			
45 – 54	4	5	116	20			
55 – 64	6	8	75	13			
> 65	0	0	44	8			
Highest qualification					$c^2 = 24.88$	2	< 0.001**
School and below	77	97	406	71			
Intermediate	2	3	105	18			
University and above	0	0	57	10			
Household member					$c^2 = 3.07$	2	0.215
≤ 3	12	15	108	19			
4 – 6	54	68	330	58			
≥ 7	13	16	130	23			
Occupation					$c^2 = 18.86$	4	< 0.001**
Unemployed/home staying	41	52	196	35			
Student	1	1	66	12			
Public service	4	5	86	15			
Industry/agriculture	14	18	77	14			
Business/administrative/professional	19	24	143	25			
Household highest income					$c^2 = 17.84$	4	0.001**
Unemployed/home staying	20	25	126	22			
Student	0	0	26	5			
Public service	5	6	132	23			
Industry/agriculture	20	25	100	18			
Business/administrative/professional	34	43	184	32			
Personal monthly income (RM)					$c^2 = 38.63$	5	< 0.001**
Not fixed	46	58	169	30			
< 1,000	11	14	71	13			
1,001 – 2,000	22	28	174	31			
2,001 – 5,000	0	0	136	24			
5,001 – 10,000	0	0	14	2			
10,001 – 20,000	0	0	4	1			
Household monthly income (RM)					$c^2 = 176.82$	6	< 0.001**
Not fixed	46	58	46	8			
< 1,000	11	14	35	6			
1,001 – 2,000	22	28	141	25			
2,001 – 5,000	0	0	254	45			
5,001 – 10,000	0	0	77	14			
10,001 – 20,000	0	0	14	2			
> 20,000	0	0	1	0			

*: $p \leq 0.05$; **: $p \leq 0.005$

highlight this observation in order to accurately reflect the findings. Education level varied significantly different between indigenous and non-indigenous people in this study (p<0.001). Almost all indigenous respondents (97%, n=77) did not receive formal education beyond secondary school level, as primary level education was mandatory in the nation according to the amendment made to the Education Act 1996 in 2002, while there were 18% (n=105) of non-indigenous respondents who completed vocational training or diplomas and another 10% studied at university level. The differences in education level will likely have affected the career opportunities of respondents. This was reflected in the significant difference in occupation between the indigenous and the non-indigenous people (p<0.001). Unemployment or being homebound was common among the indigenous community (52%), followed by self-employment/small-scaled business (24%) and manual workers in agricultural and industrial factories (18%). Only 1% of the indigenous respondents were student despite averaging younger age among the cohort. Comparatively more non-indigenous people worked in administrative, business or professional roles (25%), and 15% (n=86) worked as service providers or government servants, 12% of the non-indigenous respondents in this study was students, and 35% were unemployed/homebound. The occupational profile reflected significant differences in personal and household incomes

between the indigenous and non-indigenous respondents (p<0.001) as more than half of the indigenous community did not have a fixed household income (58%) and none of the households were earning more than MYR2,000 (around USD420) per month, while 45% of the non-indigenous household had monthly income between MYR2,000-5,000. Although the indigenous respondents generally had lower income, the money was used to support family of an equivalent size to the non-indigenous respondents (p=0.215).

Frequency of Extreme Weather Events

The questionnaire asked about the perception of the participants of the frequency of extreme weather events in the next 20 years. Most of the respondents (69%) agreed that drought would crucially affect water supply (Table II). Higher percentage of indigenous respondents (76%), who were all from lower income groups, perceived increased occurrence of drought in the near future, than the non-indigenous respondents (68%).

Indigenous people in this study, whose demographic tended towards lower education level and lower income level, perceived increased occurrence of intense precipitation (76%) compared with non-indigenous people (p=0.003). Indigenous people (around 75%) perceived that there would be more starvation and poverty due to global warming, while around 20% of non-indigenous respondents, where the most educated respondents were part of, were indifferent towards the prevalence of starvation and poverty.

Respondents from the indigenous groups (76%), where many were manual workers, generally believed that heat waves would increase in the next 20 years. With continuing global warming, 74% indigenous and 63% non-indigenous people perceived more forest fires in this study, 74% of indigenous and 67% of non-indigenous respondents felt that global warming would likely cause more disease epidemics.

In relation to elevated sea levels caused by global warming, 76% of indigenous people perceived an increased need to leave coastal cities, compared to 64% non-indigenous people (p < 0.001). For refugee issues, 74% of indigenous respondents (p=0.002) perceived surging prevalence in future.

Interestingly, when asked about global warming's impact on desertification, hurricane, extinction of species and glacier melting, respondents selected similar responses. Indigenous community respondents felt that there would be deterioration and increased instances for these extreme weather in the next 20 years. Interestingly however, on the topic of species extinction, a higher percentage of non-indigenous community respondents perceived loss of wider range of species compared to other respondents.

Casualties of Global Warming

When asked to predict the annual fatality of uncontrolled global warming (Table III), most (47%) of indigenous people speculated hundreds, followed by thousands (29%), and 20% of them didn't know the response to this question. For non-indigenous respondents, there were 30% that predicted thousands, and up to 25% that predicted millions, while 24% predicted hundreds, and 16% of them hadn't a clue regarding this question. This trend is similar when the respondents were asked about mortality rate in the next 50 years (p<0.001). Compared to non-indigenous respondents, indigenous respondents perceived thousands – millions of injuries or sickness per annum (p<0.001), this perceived rate were reduced to hundreds when asked about the next five decades (p<0.001).

While most respondents were concerned about impacts of global warming towards the country and agreed that the outcome would be negative, indigenous respondents, who most were from the least educated group, were more inclined to believe the imminent damage would arrive within 10 years, but the non-indigenous respondents would believe it takes another 25 to 50 years (p<0.001). Indeed, 95% of indigenous people were concerned about global warming's impact on all people, significantly higher than the non-indigenous people (72%, p<0.001). Level of awareness became intense as 90-97% of indigenous people were very concerned about impact of global warming towards children (p<0.001), particularly the children in their household (p<0.001).

An overwhelming number of indigenous respondents (97-99%) were very concerned about impacts of global warming on themselves, especially on their health and lifestyle, compared to 50% of non-indigenous respondents (p<0.001). Apart from their own self, the indigenous respondents also showed more concerns towards their families and community than the non-indigenous people (p<0.001). None of the indigenous respondents thought global warming would have no effect on local community. Indigenous people, however, became slightly less concerned about the wider country or their region of the World. A small percentage of them thought Malaysia would only suffer little impact from the changing climate. While 20% of indigenous respondents were unable to respond, non-indigenous respondents expressed stronger concern towards Malaysia as they perceived great damage for both developed (p = 0.002) and developing countries (p<0.001). Although indigenous people were very concerned about the impacts of global warming on their children, their responses was not as concerning for future generation. Conversely, a higher percentage of the non-indigenous respondents showed great concern towards future generations (p=0.014).

Perceptions on Air Quality

This study also focused on respondents' perceptions towards air quality (Table IV). The non-indigenous community appeared to pay more attention towards air quality in their residential area as 86% expressed moderate to high concern (p<0.001). Between July and December, when haze episode was more likely to occur, respondents were affected in significantly different ways (p<0.001), as 85% of the indigenous community were not aware of any change in air quality, but up to 70% of the non-indigenous respondents claimed to suffer moderate to serious breathing problems.

When air quality dropped, indigenous respondents tended to be unaware, and 86% of them did not know if the children in their household were having breathing difficulties or not (p < 0.001). Surprisingly, 70% of non-indigenous people in this

Table II: Comparison of perception on impacts of global warming over the next 20 years if nothing is done to address it between respondents of indigenous community and non-indigenous community.

	Indigenous (n = 79)		Non-indigenous (n = 568)		p-value
	n	%	n	%	
Drought					<0.001**
Less	1	1	64	12	
No difference	2	3	30	5	
More	60	76	384	68	
Don't know	16	20	90	16	
Heavy precipitation					0.003**
Less	1	1	64	11	
No difference	2	3	65	11	
More	60	76	340	60	
Don't know	16	20	99	17	
Flood					0.005**
Less	1	1	73	13	
No difference	2	3	56	10	
More	60	76	347	61	
Don't know	16	20	92	16	
Famine					0.002**
Less	1	1	59	10	
No difference	2	3	47	8	
More	60	76	360	64	
Don't know	16	20	102	18	
Poverty					<0.001**
Less	1	1	65	11	
No difference	2	3	61	11	
More	60	76	347	61	
Don't know	16	20	17	17	
Heat wave					0.013*
Less	1	1	48	9	
No difference	2	3	40	7	
More	60	76	388	69	
Don't know	16	20	92	16	
Forest fire					0.041*
Less	1	1	52	9	
No difference	3	4	59	10	
More	59	74	361	63	
Don't know	16	20	96	17	
Epidemics					0.003**
Less	1	1	60	10	
No difference	3	4	46	8	
More	59	74	376	67	
Don't know	16	15	86	15	
Leaving coastal cities					<0.001**
Less	1	1	62	11	
No difference	2	3	50	9	
More	60	76	361	64	
Don't know	16	20	95	17	
Refugee					0.002**
Less	1	1	56	10	
No difference	4	5	80	14	
More	58	74	326	57	
Don't know	16	20	106	19	
Desertification					0.035*
Less	1	1	59	11	
No difference	4	5	57	10	
More	58	73	346	61	
Don't know	16	20	106	19	
Hurricane					<0.001**
Less	1	1	56	9	
No difference	2	3	70	12	
More	58	73	342	60	
Don't know	18	23	100	18	
Extinction of species					0.078
Less	1	1	65	11	
No difference	3	4	42	7	
More	59	74	372	64	
Don't know	16	20	89	16	
Glacier melting					0.025 *
Less	1	1	56	10	
No difference	2	3	47	8	
More	59	74	362	64	
Don't know	17	22	102	18	

*: $p \leq 0.05$; **: $p \leq 0.005$.

Table III: Comparison of perception on current and future morbidity and mortality caused by global warming between indigenous respondents and non-indigenous respondents.

	Indigenous (n = 79)		Non-indigenous (n = 568)		p-value
	n	%	n	%	
Annual global death					<0.001**
None	2	3	26	5	
Hundreds	37	47	139	24	
Thousands	23	29	168	30	
Millions	1	1	144	25	
Don't know	16	20	91	16	
Annual global injury and sick					<0.001**
None	2	3	26	5	
Hundreds	25	32	114	20	
Thousands	35	44	210	37	
Millions	1	1	127	22	
Don't know	16	20	91	16	
Death in the next 50 years					<0.001**
None	2	3	26	5	
Hundreds	43	54	103	18	
Thousands	16	20	170	30	
Millions	2	3	147	26	
Don't know	16	20	122	21	
Injury and sick in the next 50 Years					<0.001**
None	3	4	26	5	
Hundreds	37	47	99	17	
Thousands	23	29	174	31	
Millions	0	0	144	25	
Don't know	16	20	125	22	
When will global warming harm people in Malaysia					<0.001**
Now, within 10 years	61	77	282	50	
Within 25 years	2	3	160	28	
Within 50 years	0	0	63	11	
Within 100 years	0	0	27	5	
Will not happen	16	20	36	6	
Concern about effects of global warming towards everyone					<0.001**
Low	1	1	88	16	
Neutral	3	4	70	12	
High	75	95	410	72	
Concern about effects of global warming towards all children					<0.001**
Low	0	0	86	15	
Neutral	1	1	68	12	
High	78	99	414	73	
Concern about effects of global warming towards your own children					<0.001**
Low	0	0	79	14	
Neutral	1	1	62	11	
High	78	99	427	75	
Concern about effects of global warming towards people in Malaysia					<0.001**
Low	0	0	70	13	
Neutral	2	3	60	11	
High	77	97	438	77	
Concern about effects of global warming towards self					<0.001**
Low	0	0	76	13	
Neutral	1	1	57	10	
High	78	98	435	76	
Concern about effects of global warming towards own health					<0.001**
Low	0	0	75	14	
Neutral	1	1	56	10	
High	78	99	437	77	
Concern about effects of global warming towards lifestyle					<0.001**
Low	1	1	77	14	
Neutral	1	1	58	10	
High	77	97	433	76	
Harm from global warming towards self					<0.001**
None/little	0	0	59	10	
Moderate	0	0	171	30	
Many	62	78	298	52	
Don't know	17	22	40	7	

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Table III: Comparison of perception on current and future morbidity and mortality caused by global warming between indigenous respondents and non-indigenous respondents.

	Indigenous (n = 79)		Non-indigenous (n = 568)		p-value
	n	%	n	%	
Harm from global warming towards family					<0.001**
None/little	0	0	57	10	
Moderate	2	3	176	31	
Many	60	76	298	52	
Don't know	17	22	37	7	
Harm from global warming towards community					<0.001**
None/little	0	0	52	10	
Moderate	41	52	219	39	
Many	21	27	256	45	
Don't know	17	22	41	7	
Harm from global warming towards residents in Malaysia					<0.001**
None/little	3	4	51	9	
Moderate	15	19	216	38	
Many	44	56	258	45	
Don't know	17	22	43	8	
Harm from global warming towards developed countries					0.002 **
None/little	2	3	49	9	
Moderate	34	43	220	39	
Many	27	34	255	45	
Don't know	16	20	44	8	
Harm from global warming towards developing countries					<0.001**
None/little	1	1	52	9	
Moderate	20	25	223	39	
Many	41	52	256	45	
Don't know	17	22	37	7	
Harm from global warming towards future generation					0.014 *
None/little	2	3	44	7	
Moderate	30	38	211	37	
Many	30	38	258	45	
Don't know	17	22	55	10	

*: $p \leq 0.05$; **: $p \leq 0.005$.

study reported moderate to serious breathing difficulties among children, and 76% reported symptoms among adults in their households. Although most indigenous respondents seemed less affected by the decline in air quality, 76% of them still expressed concern towards current air quality and that expected in the next 10 years, while the non-indigenous respondents, comprised of higher percentage of respondents with higher education, tended to be more worry about air quality within next 25 to 50 years ($p<0.001$).

DISCUSSION

This study had a relatively large sample size and formed a typical representation of the population living in the river basin involving a range of socioeconomic groups. The sample size for the indigenous group of 105 was almost reached (n=79), but the researchers were limited in ability to access indigenous respondents as some potential participants did not live in communities and were not accessible through the Johor Orang Asli Association (JAKOA). Despite this, with permission from the JAKOA, and use of cloud-data-based electronic questionnaires, accessibility by the communities was successful in recruiting 79 indigenous and 568 non-indigenous respondents. The terminology for "climate change" in this questionnaire was uniformly replaced with "global warming" to prevent dissociated response.[32]

Freshwater accessibility was linked to the livelihood and wellbeing of the respondents in this study, hence it is a reasonable assumption that global warming and the resulting drought in the coming decades will continue to be a major concern among the communities, especially the less educated and those struggling with poverty, as obtaining a living from fishing and obtaining drinking water will likely be more problematic and difficult in the future. Similar to other developing countries that rely heavily on adequate water resource for economic growth[33,34], climate variability played a vital role in the sustainability of communities in this study. Indigenous respondents, whose occupation were generally agricultural-based, were very concerned about food security and poverty, echoing the findings of a previous study that correlated changing climate to the vicious cycle of crop depletion, income reduction and inability to afford daily necessities.[20] While low education levels made technology-based interventions more challenging in non-urban areas[24] manual workers who were most likely to spend working

Table IV: Comparison of perception on air quality in within the community between indigenous respondents and non-indigenous respondents.

	Indigenous (n = 79)		Non-indigenous (n = 568)		p-value
	n	%	n	%	
Concern towards air quality in village					<0.001**
None/little	2	3	48	8	
Moderate	30	38	266	47	
Many	29	37	224	39	
Don't know	18	23	30	5	
Breathing problem during haze					<0.001**
None/little	1	1	125	22	
Moderate	7	9	282	50	
Many	4	5	115	20	
Don't know	67	85	46	8	
Breathing problem among children during unsatisfactory air quality					<0.001**
None/little	1	1	129	23	
Moderate	4	5	246	43	
Many	6	8	153	27	
Don't know	68	86	40	7	
Breathing problem among adult during unsatisfactory air quality					<0.001**
None / Little	3	4	77	14	
Moderate	37	47	265	47	
Many	5	6	163	29	
Don't know	34	43	63	11	
Concern towards future air quality in village					<0.001**
Now	23	29	171	30	
Within 10 years	37	47	158	28	
Within 25 years	1	1	132	23	
Within 50 years	0	0	49	9	
Within 100 years	0	0	17	3	
Will not happen	18	23	41	7	

*: $p \leq 0.05$; **: $p \leq 0.005$.

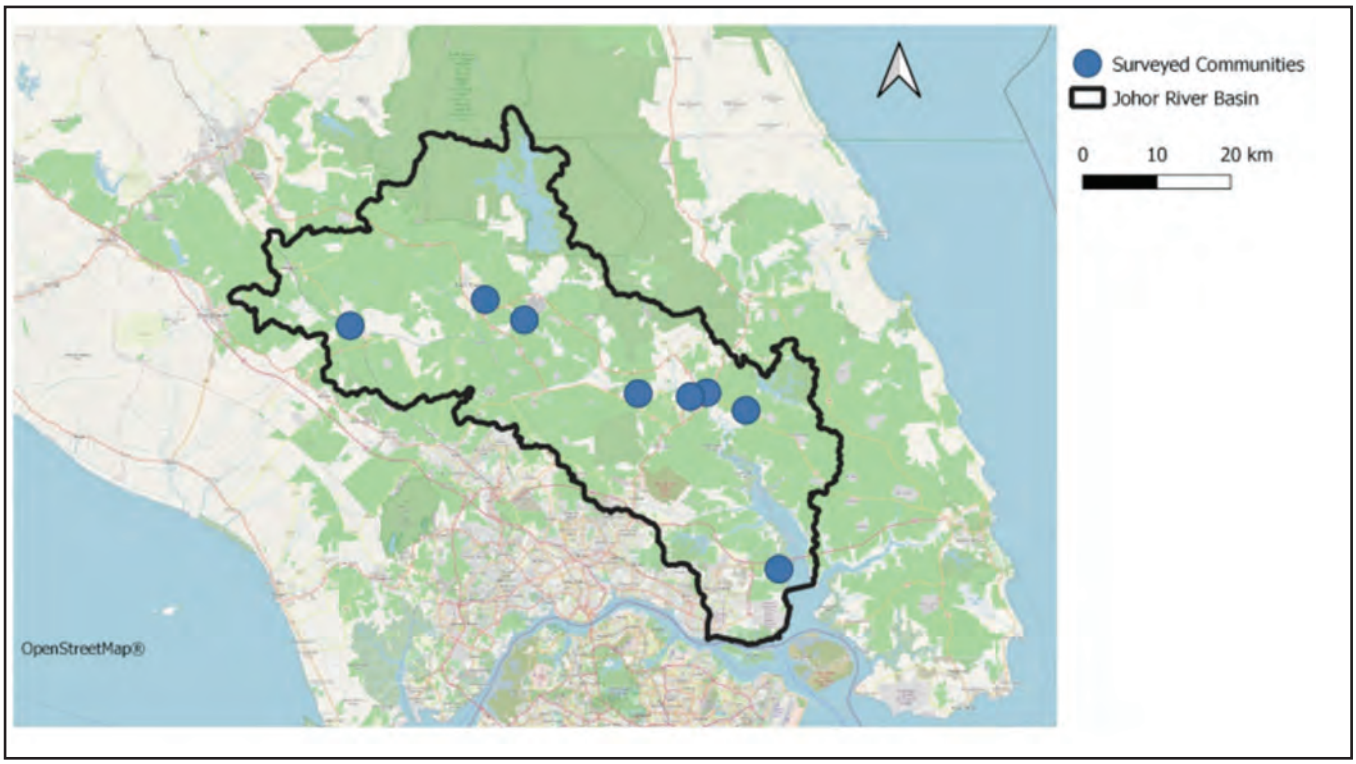

Fig. 1: Map showing area of study and distribution of recruited respondents.

hours outdoors perceived that heat waves would be an increasing problem in the future and they would increase occupational heat stroke and reduce labour productivity unless working environment practices were improved.[35]

Data collection covered most of the Johor River Basin including from flood hotspots. Some respondents in this study had experienced involuntary displacement and loss of property in the past and tended to perceive worsening conditions in future with precipitation, flood and leaving coastal areas because they were becoming more prone to flooding with elevated sea levels. Residents of rural areas such as riverside areas and plantations, many of whom were indigenous residents, were generally worried about their resilience to disaster, compared to the urban dwellers who felt they were better equipped with knowledge and financial support in times of disaster from personal income and government help. Lack of appropriate baseline knowledge regarding weather disasters and the association with global warming would be costly to the residents at flood hotspots, thus relevant public education were crucial. In Johor, most public education campaigns were deployed as post-disaster management measures and people felt they didn't have enough time to prepare for future events. It was also evident that misinformation spread easily so people were not sure what they were required to do to mitigate disaster effects most efficiently. Interestingly, respondents in this study exhibited moderate to high levels of concern towards weather events that were less relevant to the Malaysian settings such as glacier melting as well as technical phrases such as extinction. This demonstrated the willingness of communities to learn new information, as showed by previous study that communities relied on multimedia and word of mouth for knowledge gaining[36] and consequently, correct representation of global warming in the local context would be crucial to increasing knowledge in future.[27]

The World Health Organization (WHO) predicted 250,000 additional deaths annually between 2030 and 2050 due to health impacts from climate change such as malnutrition and heat stress.[37] In this study, although the indigenous respondents were worried about their health under changing climate, most of them underestimated the mortality rate by at least a factor of 10. Higher education and high-income did not prompt a closer estimation to the figure provided by WHO, and more than 20% of respondents had no idea of the mortality rate in 50 years, similar to previous study collected in multiple nations.[30] This could be due to the lack of public education, both within the formal education syllabus and public awareness campaigns.[38] As global warming continues, most respondents speculated more epidemics rather than death, which indicated their anxiety for another public health emergency after experiencing the COVID-19 pandemics. WHO estimated direct damage costs to health by global warming at USD2-4 billion per annum worldwide[37] and increasing medical costs were of great concern and seen as a unwelcome burden on top of inflation, as reflected by high income respondents that tended to disregard their concerns for climate change-borne epidemics or injuries, until 25 years' time when they might be at retirement age with a limited source of income. Although specific diseases or symptoms were not asked about, the findings from this study suggested that all respondents were aware of the health risks brought by global warming. The indigenous community were generally more concerned and sensitive towards the effect of global warming on their health and wellbeing as a current threat rather than a future threat. The response could likely be due to their existing struggle maintaining their lifestyle and livelihoods making them more vulnerable to climate change in the future. These findings are in agreement with previous studies that showed agricultural workers were generally well aware of climate change issues and were keen to learn new adaptation techniques and strategies.[23,24] Compared to non-indigenous respondents, the indigenous people in this study demonstrated intense concern for health impact of global warming towards self and family members, especially children. Besides having a sense of responsibility towards individuals close to them, such a strong response could be due to the lack of confidence in receiving help from sources outside of their communities. Healthcare inequality such as limited medical facilities and health supplementary had also affected how minority groups such as the indigenous community perceive risk under changing climate.[39] In comparison, non-indigenous respondents expressed stronger concern towards the impact of climate change on the country as a whole and future generations. This may have reflected the difference of community involvement in decision making and policy formulation at the national level.

Malaysia and the equatorial SEA countries experience southwest monsoon from June to September where the weather pattern brings pollutants resulting from forest burning, causing haze in the region.[40] As Peninsular Malaysia is one of the regions suffering worst from seasonal haze, public perception on air quality and the consequential health impacts were important for development of efficient adaptation measures. In contrast to global warming and other climate issues, non-indigenous respondents showed higher awareness on air quality issues and were more concerned towards the health impacts of declining air quality, especially during haze than non-indigenous people. The indigenous and non-indigenous respondents recalled strikingly different experience during last haze episode, as more than 80% of indigenous people did not register breathing problems and were unaware of any symptoms among their household members, but more than 70% of non-indigenous people in this study reported breathing difficulties themselves as well as among children and family members. Studies of visits to clinic and hospital admission records have shown that haze has been associated with spikes in respiratory symptoms both in Malaysia and Singapore.[17,40] However, such reports have been based mostly on densely populated urban areas, which would under-represent experiences of minorities such as indigenous communities and residents of rural areas. Previous study in various states of Malaysia have demonstrated that public understanding on association between urbanisation and air pollution were generally high, and people well educated on sources of pollutants such as industries and vehicle emissions.[14] In comparison, indigenous respondents in this study were likely to be less exposed to information regarding declining air quality and its associated health risks, so they therefore would not pay specific attention to surrounding air quality

unless otherwise notified. The nature of their occupations in agriculture and fishing might not however allow for a reduction in the amount of time spent outdoors.

CONCLUSION

This study demonstrated significant differences in the perception of the effects of global warming and associated implications on health risks between indigenous and non-indigenous respondents for the future. Further studies could improve understanding of factors underlying communities' attitude towards impacts of changing climate and the accompanying behavioural changes that may be required to mitigate risk. The findings of this study are useful for formulation of public health education programmes and refinement on current climate change mitigation policies to target and benefit the wider Malaysian society.

ETHICAL APPROVAL

Ethical approval was granted from the Newcastle University Ethics Committee (1597/2020).

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