

Paper:

Assessment of Natural Disaster Coping Capacity from Social Capital Perspectives: A Case Study of Bangkok

Sutee Anantsuksomsri^{*,**} and Nij Tontisirin^{***,†}

^{*}Department of Urban and Regional Planning, Faculty of Architecture, Chulalongkorn University
254 Phayathai Road, Patumwan, Bangkok 10330, Thailand

^{**}Regional, Urban, and Built Environmental Analytics, Faculty of Architecture, Chulalongkorn University, Bangkok, Thailand

^{***}Faculty of Architecture and Planning, Thammasat University, Pathumthani, Thailand

[†]Corresponding author, E-mail: nij@ap.tu.ac.th

[Received November 13, 2019; accepted July 9, 2020]

Many cities and regions have recently experienced economic and environmental losses due to natural disasters. Economic losses are particularly high in urban areas where population and many economic activities are highly concentrated. Urban communities' abilities and capacities to cope with natural disasters are essential to understand the impacts of natural disasters. Urban communities' coping capacity is found to be closely linked to social capital of such communities. This paper aims to assess the natural disaster coping capacity of urban residents with social capital approach. The case study is Bangkok, Thailand. Using principal component analysis (PCA), the analysis shows that social cohesion, empowerment, and trust plays a key role in social capital level of Bangkok residents. Mapping social capital index at the district level suggests that urbanization may be contributable to the level of social capital.

Keywords: coping capacity, social capital, principal component analysis, Bangkok

1. Coping Capacity and Social Capital

Natural disasters have caused economic and environmental losses to the society. These losses are particularly high in urban areas where population and economic activities are clustered. Urban communities' abilities to prepare for, respond to, and recover from extreme events and natural disasters are essential in the disaster management cycle [1]. Such abilities are known as 'coping capacity' of a community.

Coping capacity is defined by Burkett [2] as "the ability of a system (natural or human) to respond to and recover from the effects of stress or perturbations that have the potential to alter the structure or function of the system." As such, coping capacity is crucial in disaster management as it is often associated with extreme events such as natural disasters or natural hazards.

Coping capacity is very much tied to social system in disaster management because it views people as active in-

dividuals with social ties [3]. Thus, social relations and networks of people are important for the understanding of the coping capacity of a community. The focus on social relations and networks is aligned with the concept of social capital [4]. In this research, we are particularly interested in social capital of households as a representation of coping capacity.

Social capital (SC) is defined by Putnam et al. [5] as features of social organization, norms, and values that create externalities for communities. SC constitutes two components: cognitive and structural. According to Grootaert and van Bastelaer [6], cognitive SC is shared trust, norms, values, and beliefs within a community while structural SC is information sharing, decision making, and collective actions of the community. Structural SC also consists of bonding, bridging, and linking types. Villalonga-Olives and Kawachi [7] specify operationalized definitions of SC. Cognitive SC can be measured as "people's perceptions of the level of interpersonal trust, sharing, and reciprocity" while structural SC can be measured as "density of social networks, or patterns of civic engagement."

Social Capital Index (SCI) can be measured in six dimensions [8] and corresponding proxies:

1. Groups and networks – memberships in local association and networks
2. Trust and solidarity – the level of trust to communities
3. Collective action and cooperation – participation in communal activities
4. Information and communication – sources of information and communication available
5. Social cohesion and inclusion – diversity in communities
6. Empowerment and political action – happiness and political participation

SC has increasingly been the focus of disaster research, particularly in the during- and post-disaster period. SC is one of the most important factors in evacuations of tsunami [9] and a volcano eruption [10]. It also plays a key role in post-disaster recovery through social relationships within the community that facilitates the process of



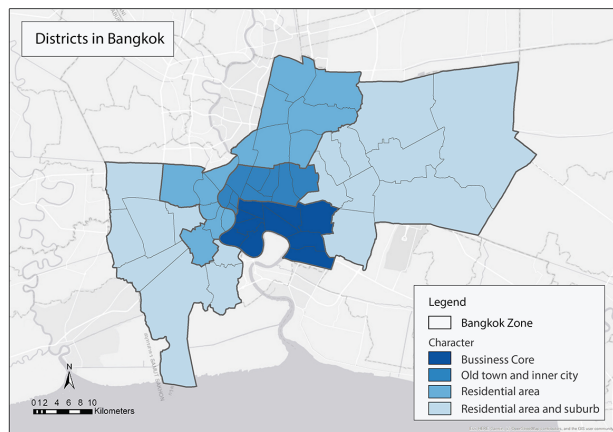


Fig. 1. Districts in Bangkok Metropolis.

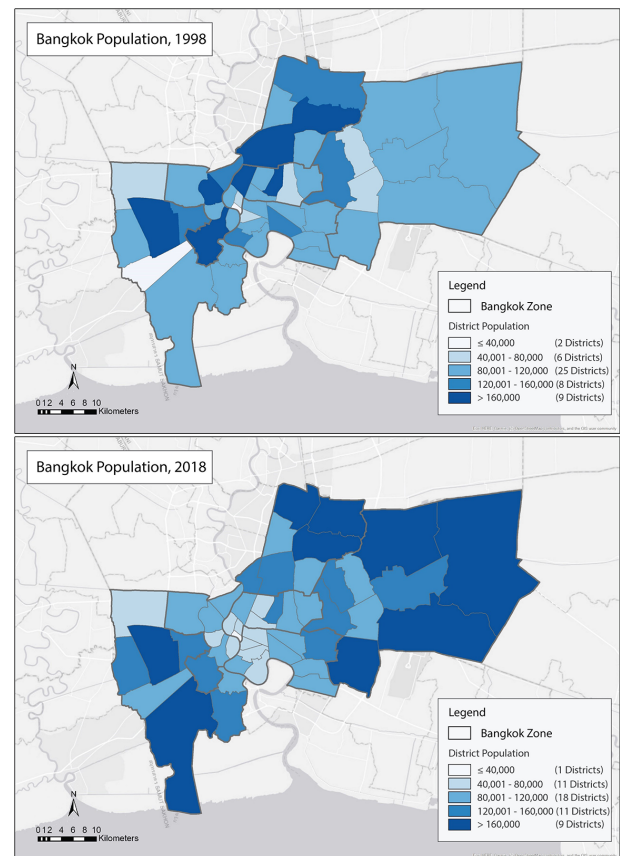
recovery such as disaster relief [11] and tsunami evacuation [9]. Kawamoto and Kim [12] also show that SC is crucial in community-based waste management in the post-disaster period. Nevertheless, little has been done to establish a better understanding of SC in the pre-disaster period. This paper aims to assess SC in the pre-disaster period as an indicator of natural disaster resilience of Bangkok residents. It also aims to assess spatial distribution of SC across 50 districts of Bangkok.

2. Bangkok Metropolis

The capital city of Thailand, Bangkok is home to over 5.6 million population in 2018 [13]. Bangkok is the major economic engine of Thailand. Bangkok population accounts for 8.5% of the total population but its share of GDP is 9.92% [14]. Bangkok Metropolis consists of 50 districts as shown in **Fig. 1**. These districts can be grouped into four zones according to general land use characteristics: (1) business core, (2) old town and inner-city, (3) residential area, and (4) residential area and suburb. Since 1998, the number of populations has increased particularly in districts in the north and the east while populations in the central area tend to decline (**Fig. 2**). However, when examining population density, districts in the central area have higher population density with the expansion to the north and the east (**Fig. 3**).

Situated in a flat land, Bangkok has experienced a risk of flooding. Many provinces in Thailand, including Bangkok, experienced a severe flood in 2011 (**Fig. 4**). The 2011 flood has caused large economic losses. It affected over 16,000 km² of agricultural lands and 9,800 factories [15]. For example, many large-scale manufacturers like Toyota and Honda had been severely flooded; hundreds of newly-assembled automobiles were under the water for weeks. This flood has long-term repercussions on the Thai economy [16]. In addition, the 2011 flood caused severe damage to residential properties because of the unplanned preparation for a natural disaster.

Since the 2011 flood, many disaster preparation docu-



Source: Author's

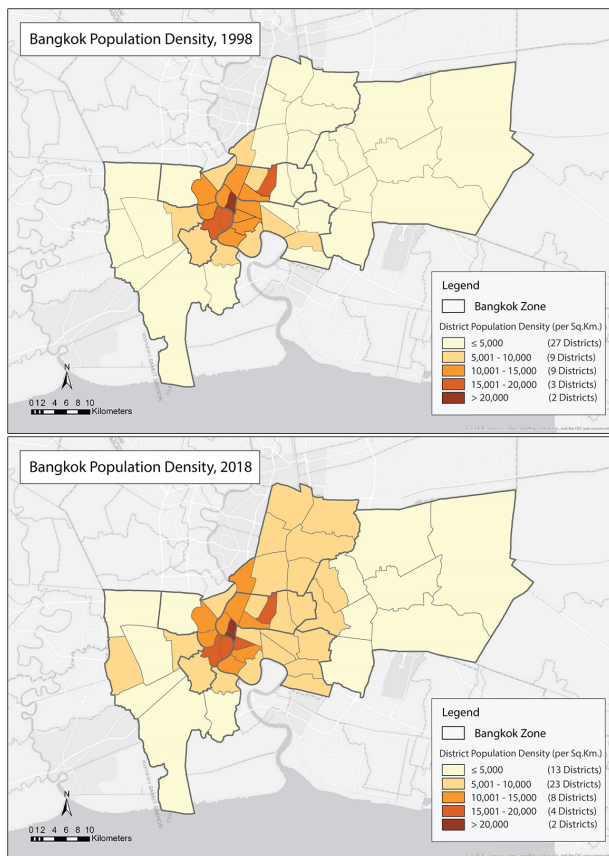
Fig. 2. Population by district, 1998 and 2018.

ments have been reported for Bangkok, raising the awareness of disaster prevention and mitigation. For instance, Flood Management Master Plan was proposed within a few months after the flood. The plan consists of two approaches: structural (such as physical infrastructure) and non-structural measures (such as water management). However, the plans tend to focus on physical infrastructure rather than communities or social aspects of disaster preparation and prevention. The absence of social aspects of disaster preparation suggests that little is known about social systems of disaster preparedness in Bangkok. This research aims to fill in this gap.

3. Data and Methodology

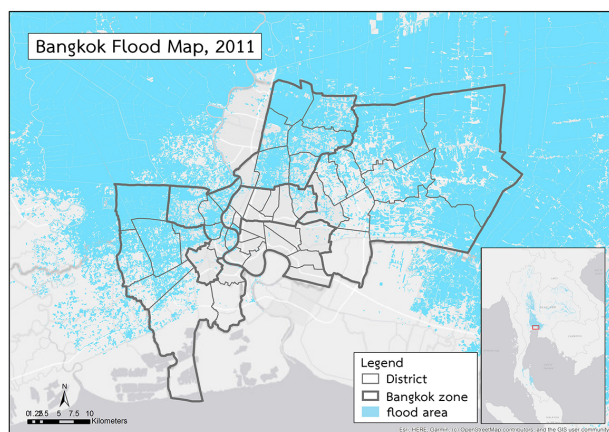
3.1. Data

The data was collected from a questionnaire survey of 1,756 samples from residents of 50 districts of Bangkok so that each district has at least 30 observations. To collect questionnaires, the researcher randomly selected an area in each district and then systematically distributed questionnaires to residential units in the area. The questionnaires were collected using face-to-face or self-administered interviews, depending on the preference of correspondents, at the end of 2019. The questionnaire assesses six dimensions of SC as discussed earlier. **Ta-**



Source: Author's

Fig. 3. Population density by district, 1998 and 2018.



Source: Author's

Fig. 4. 2011 Flood in Bangkok.

ble 1 shows key questions and their corresponding answers from the survey.

For the first dimension, groups and networks, the questionnaire asks whether households members of correspondents participate or are participating with social groups and whether they have friends who can help them during a natural disaster. Almost 90% of correspondents are involved with social groups while around 61% have close friends who can assist them during a natural disaster.

The second dimension, trust and solidarity, consists of

two questions: (1) whether other people can be trusted and (2) whether people in the neighborhood are willing to help. The correspondents' opinion of whether other people can be trusted is split about half between trust (48.2%) and do not trust (51.8%). On the other hand, around 27.46% strongly agree that most people in the neighborhood are willing to help while 3.86% strongly disagree.

As for collective action and cooperation, three questions are asked: (1) about participation in the communal activities in the past 12 months, (2) their opinion on the cooperation of communities during a natural disaster, and (3) bonding among communities. Around three-fourth of correspondents did not participate in communal activities. More than half of correspondents think that people in the community are very likely to cooperate during a natural disaster.

The fourth dimension, information and communication, asks for three main sources of information. The top three answers include television (71.24%), relatives, friends, and neighbors (59.45%), and internet/social media (53.02%).

The fifth dimension, social cohesion and inclusion, consists of two questions: (1) about the difference in social and economic status in the communities and (2) about feeling safe at home. The majority of correspondents responded that there is no difference in the communities (36.03%). More than half of correspondents think that their home is safe from crime.

The last dimension, empowerment and political action, asks about (1) how happy they are, (2) their opinion about the power to make a change, and (3) whether they voted in the previous election. The majority of the correspondents are moderately happy (40.72%) and very happy (33.16%). The majority of correspondents also think that they mostly can change the course of their life (47.48%) and totally can change (16.06%). Finally, more than 80% voted in the previous election.

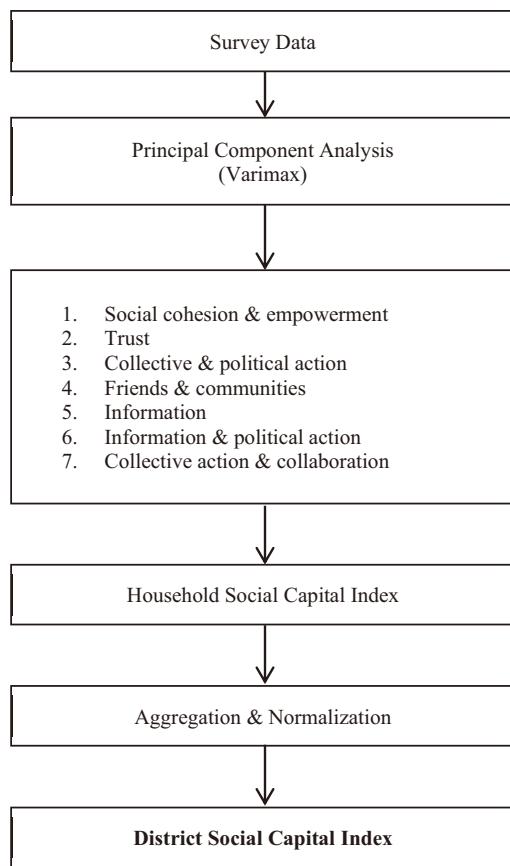
3.2. Principal Component Analysis (PCA)

To assess natural disaster coping capacity from a social capital perspective, principal component analysis (PCA) is used. PCA is a statistical procedure that uses an orthogonal transformation to convert a number of possibly correlated variables into a smaller number of linearly uncorrelated variables called principal components. It is widely used for data reduction simplifying the complexity of high-dimensional data into a smaller set of components with fewer dimensions [17]. PCA has been used as a promising procedure in deriving the composite score of SC level [18–20].

Figure 5 shows the procedure of the analysis. The first step is to conduct PCA with 15 variables that are proxies of six SC dimensions discussed earlier. Seven components with an eigenvalue greater than one are identified. Factor loadings are also computed for each component. Then, a SCI for each household is estimated from a linear combination of all components, assuming that each component contributes equally to the SC [21]. Finally, SCIs

Table 1. Six dimensions of social capital.

SC	Variable		
	Question	Answer	%
Groups and networks	1. Are your household members involved with social groups or associations (that have regular activities)? (1a)	1: Yes 0: No	89.29 10.71
	2. Do your household members have close friends who can be consulted or able to give help during natural disaster? (1b)	1: Yes 0: No	60.71 39.29
Trust and solidarity	1. Generally, how would you say about dealing with most people? (2a)	1: People can be trusted 0: You can't be too careful	48.20 51.80
	2. Most people in the village/neighborhood are willing to help if you need it. (2b)	1: Disagree	3.86
		2:	5.64
		3:	34.60
		4:	28.44
		5: Agree	27.46
Collective action and cooperation	1. In the past 12 months, did you or anyone in your household participate in any communal activities? (3a)	1: Yes 0: No	24.73 75.27
	2. If there is natural disaster, how likely is it that people in the community will cooperate to try to solve the problem? (3b)	1: Unlikely	0.23
		2:	0.70
		3:	19.78
		4:	26.93
		5: Likely	52.36
	3. How bonding among community do you think your household is? (3c)	1: Small 2: 3: 4: 5: Great	0.18 8.57 57.08 27.38 6.79
Information and communication	1. What are your three main sources of information about what the government is doing (top 3 sources)? (4)	a: Relatives & friends b: Community bulletin board c: Local market/barber d: Newspaper/magazines e: Radio f: Television g: Groups or associations h: Colleagues i: Political network j: Community leaders k: Agents of the government l: NGO m: Internet	59.45 12.70 9.05 12.19 7.86 71.24 0.85 20.73 1.54 20.10 9.85 0.17 53.02
Social cohesion and inclusion	1. In your community, to what extent do community members differ in terms of social and economic status? (5a)	1: No different 2: Small extent 3: 4: 5: Great extent	36.03 25.80 27.07 9.89 1.21
		1: Very unsafe 2: 3: Neither safe or unsafe 4: 5: Very safe	1.89 17.03 18.41 30.85 31.82
	2. In general, how safe from crime and violence do you feel when you are at home? (5b)	1: Very unhappy 2: 3: Neither happy or unhappy 4: 5: Very happy	1.20 5.96 18.96 40.72 33.16
		1: Totally unable to change life 2: 3: Neither able nor unable 4: 5: Totally able to change life	1.83 9.75 24.89 47.48 16.06
	3. In the recent election, did you vote? (6c)	1: Yes 0: No	82.76 17.24



Source: Author's

Fig. 5. Analysis procedure.

Table 2. Eigenvalue of components.

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.716	0.187	0.114	0.114
Comp2	1.529	0.127	0.102	0.216
Comp3	1.402	0.161	0.094	0.310
Comp4	1.241	0.046	0.083	0.393
Comp5	1.195	0.117	0.080	0.472
Comp6	1.078	0.067	0.072	0.544
Comp7	1.011	0.087	0.067	0.612

are aggregated (for the mean) by district and normalized so that the district SCI ranges from 0 to 1.

4. Results

After removing missing values, 1,521 observations remain in the PCA. The PCA reveals 15 components but only 7 components have the value of eigenvalue higher than one. Thus, the analysis will focus only on these 7 components. **Table 2** shows the eigenvalue of each component and its respective proportion. Altogether these 7 components can explain about 61.2% of the variation of variables.

Factor loadings (rotated) reveal that each component consists of various key variables across different SC com-

ponents as shown in **Table 3**. With this grouping, these 7 components can be interpreted as follows:

1. Social cohesion & empowerment
2. Trust
3. Collective & political action
4. Friends & communities
5. Information
6. Information & political action
7. Collective action & collaboration

The results show that social cohesion & empowerment play a key role in SC in Bangkok. Trust is the second major component, followed by collective action, communities, information, political action, and collective action. Most of factor loadings have positive sign, suggesting that higher level of trust leads to higher level of SC. However, there are a few variables with negative sign of factor loadings, for example, Participation of communal activities (3a) in the 2nd component, which reflect low level of communal participation of urban residents. In addition, the negative sign of Receiving information from relatives, friends, and neighbors (4a) in the 5th and 6th components implies that information from relatives, friends, and neighbors could be conflicting and unverified, which could lead to confusion when receiving such information, unlike information from mainstream media such as television (in the 5th component) or social media (in the 6th component).

With these factor loadings, a score of each principal component is calculated. **Fig. 6** shows a spatial distribution of seven principal component scores, averaging at the district level. **Table 4** compares these principal component scores with district characteristics. Districts in residential areas and suburb tend to have high scores of the 2nd component (trust), the 3rd (collective & political action), and the 6th (information & political action), suggesting that residents in these districts build SC through having trust with each other and participating in social groups. On the other hand, districts with high population density like in the old town and inner-city areas tend to have high scores of the 1st component (social cohesion & empowerment), the 5th (information), and the 7th (collective action & collaboration), suggesting that residents in these districts build SC through self-empowerment, diversity, and communal participation.

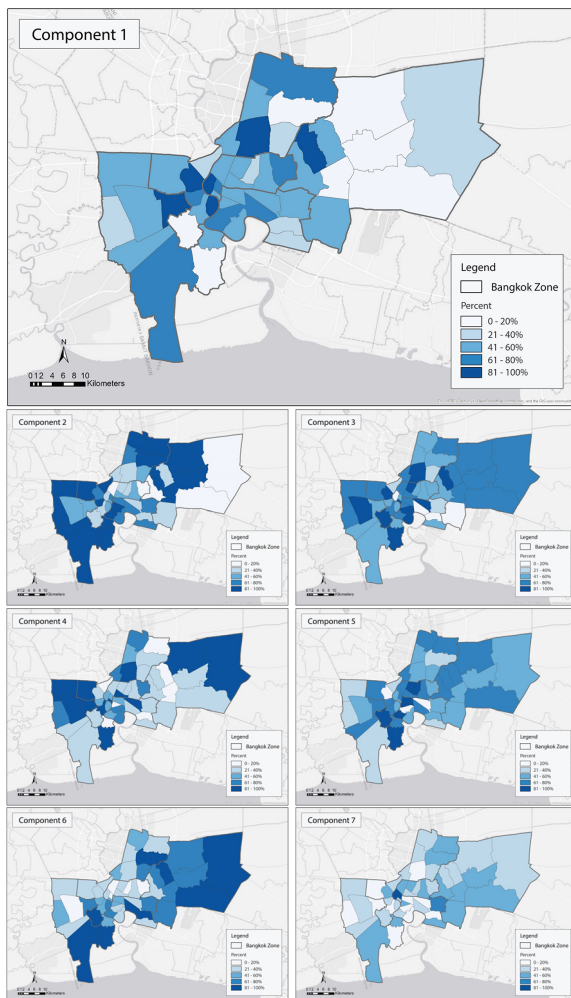
With the results of PCA, SCI at the household level can be estimated. This household SCIs are then aggregated at the district level (average) and normalized so that the range of the index is between 0 to 1. **Fig. 7** shows the SCI at the district level. **Table 5** shows averages of district population, density, and SCI by district characteristics.

As can be seen in **Fig. 7**, districts in residential areas and suburb had been flooded in 2011, suggesting that an experience of disaster of residents in such districts may positively influence their SC. A closer look at SCI by district characteristics shows that districts in the old town and inner-city with high population density tend to have lower SCIs in comparison with districts with lower population density. In other words, settlements with close-knit com-

Table 3. Components and corresponding key variables.

#	Component	Key variable	Factor loadings
1	Social cohesion & empowerment	Feeling safe from crime at home (5b)	0.6066
		Feeling happy (6a)	0.628
		Feeling empower to change your life (6b)	0.4107
2	Trust	Trust of others (2a)	0.6492
		Trust of neighbors (2b)	0.6358
		Participation of communal activities (3a)	-0.3143
3	Collective & political action	Involvement with social groups (1a)	0.5801
		Social similarity (5a)	-0.647
		Voted in previous election (6c)	0.3727
4	Friends & communities	Having close friends who can help (1b)	0.6758
		Cooperation in the community (3b)	0.7199
5	Information	Receiving information from relatives, friends, and neighbors (4a)	-0.5446
		Receiving information from television (4f)	0.7569
6	Information & political action	Receiving information from relatives, friends, and neighbors (4a)	-0.3799
		Receiving information from social media (4m)	0.6823
		Voted in previous election (6c)	0.5851
7	Collective action & collaboration	Participation of communal activities (3a)	0.5635
		Bonding among communities (3c)	0.7635

Note: Kaiser–Meyer–Olkin measure of sampling adequacy = 0.5238.



Source: Author's

Fig. 6. Analysis procedure.

munities like in the suburb are likely to have higher level of SC through community bonding, trust, information exchange, and collaboration.

5. Conclusions

This research examines a natural disaster coping capacity of urban residents through the lens of SC. Following Grootaert et al. [8], the analysis measures six dimensions of SC of Bangkok residents. The survey was conducted using the quota sampling method so that samples are collected from all 50 districts of Bangkok.

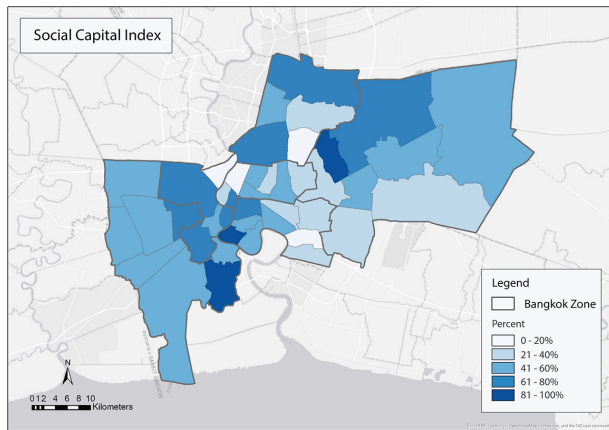
To assess the SC of Bangkok residents, principal component analysis (PCA) is used. PCA reveals that there are 7 major components of SC, namely (1) social cohesion & empowerment, (2) trust, (3) collective & political action, (4) friends & communities, (5) information, (6) information & political action, and (7) collective action & collaboration. The results suggest that major components of the SC of Bangkok residents are social cohesion, citizen empowerment, and trust.

The spatial distribution of SC shows that districts with a high level of SC are likely to be less urbanized than districts with a low level of SC. This could be because less urbanized settlements tend to be communities that are tightly knit, that is, people in the community know and trust each other. Urban communities tend to lack these types of relationships.

Further studies can incorporate other social, economic, and physical factors such as demographics and built environment characteristics. The weight of each principal component can also be explored in a further studies in order to obtain a better estimation of SCI.

Table 4. Summary of principal component scores by district characteristic.

Characteristic	1	2	3	4	5	6	7
Business core	0.48	0.61	0.58	0.49	0.55	0.56	0.28
Old town and inner-city	0.58	0.35	0.60	0.50	0.66	0.21	0.48
Residential area	0.56	0.65	0.62	0.52	0.56	0.50	0.30
Residential area and suburb	0.43	0.68	0.65	0.48	0.60	0.61	0.33



Source: Author's

Fig. 7. Analysis procedure.

Table 5. Summary of population, density, and social capital index by district characteristic.

Characteristic	Population	Density	SCI
Business core	83,136	7,721	0.46
Old town and inner-city	74,514	10,663	0.43
Residential area	126,834	7,173	0.54
Residential area and suburb	141,117	3,498	0.55

Acknowledgements

This research was supported by the Sumitomo Foundation Fiscal 2018 Grant for Environmental Research Projects, and partially supported by Science and Technology Research Partnership for Sustainable Development (SATREPS) in collaboration between Japan Science and Technology Agency (JST, JPMJSA11708) and Japan International Cooperation Agency (JICA).

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Name:
Sutee Anantsuksomsri

Affiliation:
Assistant Professor, Faculty of Architecture,
Chulalongkorn University

Address:

254 Phayathai Road, Patumwan, Bangkok 10330, Thailand

Brief Career:

2012- Visiting Lecturer, Department of City and Regional Planning,
Cornell University
2013- Assistant Professor, Institute for Advanced Study, Waseda
University
2016- Lecturer, Faculty of Architecture, Chulalongkorn University
2018- Assistant Professor, Faculty of Architecture, Chulalongkorn
University

Selected Publications:

- “Standage estimation of rubber (*Hevea brasiliensis*) plantations using an integrated pixel- and object-based tree growth model and annual Landsat time serie,” ISPRS J. of Photogrammetry and Remote Sensing, Vol.144, pp. 94-104, 2018.
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 - Regional Science Association International (RSAI)
-



Name:
Nij Tontisirin

Affiliation:
Assistant Professor, Faculty of Architecture and
Planning, Thammasat University

Address:

Thammasat University Rangsit Campus, Klongluang, Pathumthani 12121,
Thailand

Brief Career:

2003- Lecturer, Faculty of Architecture and Planning, Thammasat
University
2009- Research Specialist, Program on Applied Demographics, Cornell
University
2015- Assistant Professor, Faculty of Architecture and Planning,
Thammasat University

Selected Publications:

- “Standage estimation of rubber (*Hevea brasiliensis*) plantations using an integrated pixel- and object-based tree growth model and annual Landsat time serie,” ISPRS J. of Photogrammetry and Remote Sensing, Vol.144, pp. 94-104, 2018.”
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