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Comparative Study of Community Resilience in Mega Coastal Cities Threatened by Sea Level Rise: The Case of Alexandria and Jakarta

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Abstract

This study aims to develop a Flood Disaster Resilience Index (FDRI), as an attempt to measure the level of communities' resilience in mega coastal cities. The FDRI is developed on five resilience-based capitals: Governance, Economic, Natural, Physical and Social. Alexandria in Egypt and Jakarta in Indonesia are selected as case studies, as they rank the 11th and the 20th in terms of population exposed to coastal flooding by 2070, according to the Organization for Economic Cooperation Development (OECD). The study showed that higher values of resilience are correlated with higher preparedness and sustainability to cope with flood disasters and vice versa.

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Keywords: Community Resilience; Sea Level Rise; Flood Disaster Resilience Index; Alexandria; Jakarta

1. Introduction

Sea Level Rise (SLR) due to climate change is a serious threat to coastal cities with heavy concentrations of population, economic activity and a fast rate of urban development. SLR threats are represented by various phenomena such as: floods, saltwater intrusion, erosion, and inundation. According to recent researches, East Asia and the Middle East and North Africa (MENA) regions would experience the largest portion of SLR impacts.

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Population impact is larger in MENA for a 1 m SLR, while it is larger in South-East Asia for a 5 m SLR (Dasgupta & Laplante, 2010; Blankespoor & Dasgupta, 2012).

Despite the growing recognition of building resilient communities to SLR, Asian and MENA urban communities have not received adequate attention yet, although that SLR impacts will affect their livelihoods, properties, and environmental quality since climate change is expected to alter the frequency and severity of SLR represented by floods (ADPC, 2004).

Many definitions of ‘resilience’ could be found in the literature. This study looks at resilience from the perspective of urban communities and is mainly focused on three characteristics: (i) capacity to absorb stress through preparedness as a way of adaptation; (ii) capacity to maintain certain basic functions and structures during disastrous events, and (iii) capacity to recover or ‘bounce back’ after an event (Twigg, 2007; Cutter & Barnes, 2008).

Measuring coastal community resilience is a complex process due to its dynamic interactions with societies and environment. However, literature has discussed various conceptual frameworks that break down coastal community resilience into general similar factors which can increase the community resilience. For example, R. Shaw and his team (Kyoto University, 2011) have proposed the Climate Disaster Resilience Index (CDRI), consisted of 25 variables, in order to measure the existing level of climate disaster resilience of targeted areas.

2. The Selection of Case Study Areas

This section illustrates the justification for choosing the areas on three levels: city, district and zone.

2.1. Selection of cities

Alexandria city -with area 300 km² and number of population equals to 4110015- is considered to be the second largest metropolitan area after Greater Cairo, an industrial center, an important tourist resort and the largest Egyptian seaport which serves approximately 80% of Egypt's imports and exports (Encyclopida Britannica, 2014). It is located between the Mediterranean coast and Lake Mariout, at the western edge of the Nile River delta as shown in Fig.1.

Jakarta city -Capital of the Republic of Indonesia- is a huge, sprawling metropolis located on the northwest of the Island of Java as shown in Fig.1. It is known to be the country's economic, cultural and political center and the most populous city in Southeast Asia and a home to 9 million people (Ministry of Tourism, 2013).

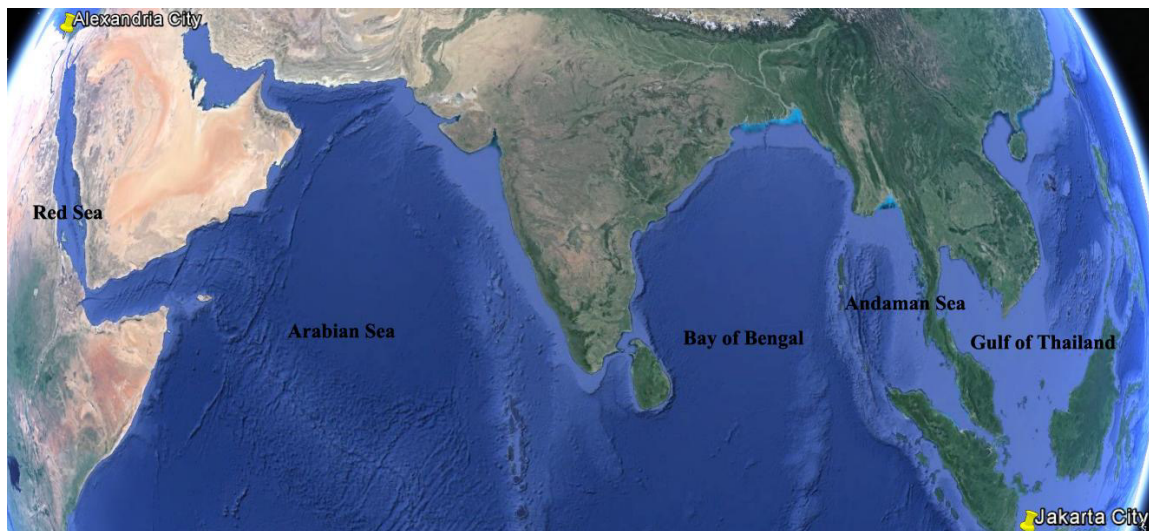


Figure 1: Location of Alexandria and Jakarta from the world (Source: Google Earth)

Among the top 20 cities ranked in terms of population exposed to coastal flooding by 2070, Alexandria and Jakarta are ranked as the 11th and the 20th, respectively (Dasgupta, Laplante, & etal, 2010). Moreover, they are ranked as the 17th and the 11th respectively in the term of exposed assets by 2070 (Nichollas & etal, 2008).

2.2. Selection of districts

Much of the Abu Qir region is below sea level as shown in Fig. 2 and includes communities with a high population density. It is therefore particularly vulnerable to potential devastating impacts of SLR (El-Nawawi, 2014).

For Pademangan, the number of population living in a land with large areas below sea level, as shown in Fig. 3, is 149809 inhabitants (BPS, 2011). It is considered one of five districts in North Jakarta, with a highly risk to inundation exaggerated by SLR (Hadi, Ningsih, & Latief, 2011).

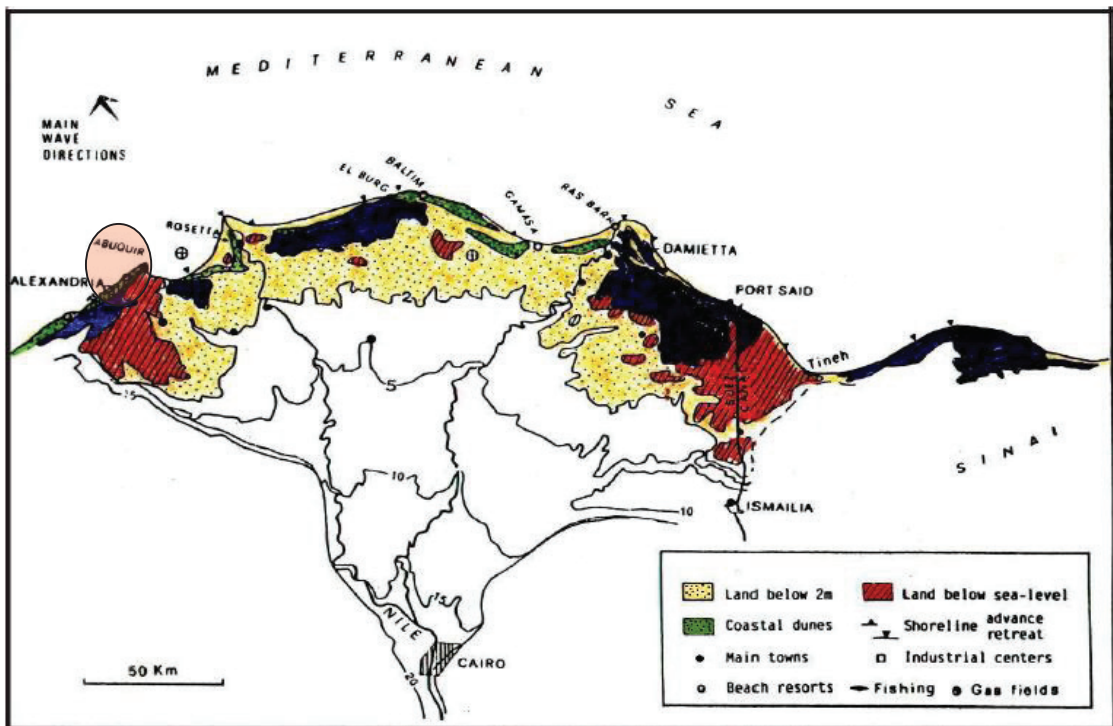


Figure 2: General topography of the Nile delta with a selection on Abo-Qeer (source: (Weekly Ahram, 2007))

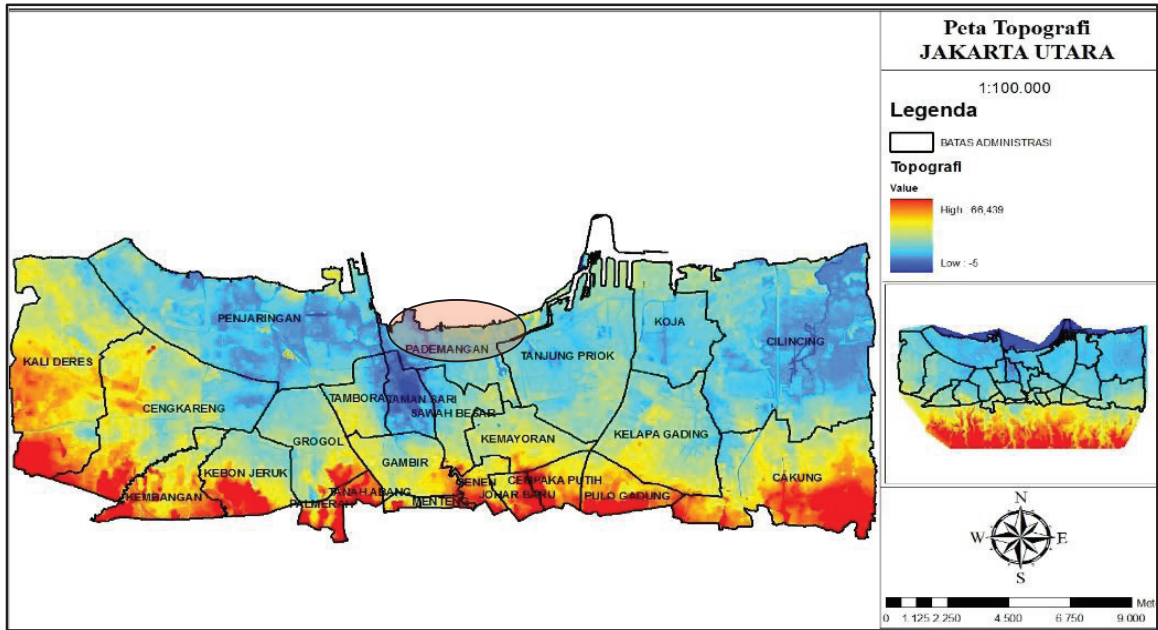


Figure 3: Topography of North Jakarta with a selection on Pademangan District (Source: (Hadi, Ningsih, & Latief, 2011). P.36)

2.3. Selection of zones

The selected zones were chosen in a way to get the community’s perspective about the five capitals taking into consideration the inclusion of different age, gender, education and socio-economic tiers. Fig. 4 represents detailed illustrations for study area in Egypt and Indonesia on four levels: country, city, district, and zone. These selections were chosen based on the previous justifications. Questionnaires have been distributed among the individuals and in-depth interviews have been held with academic, governmental officials, NGOs, private and public sectors representatives in both cities.



Figure 4: Illustration for the study area on four levels: country- city- district- zone, a: Egypt

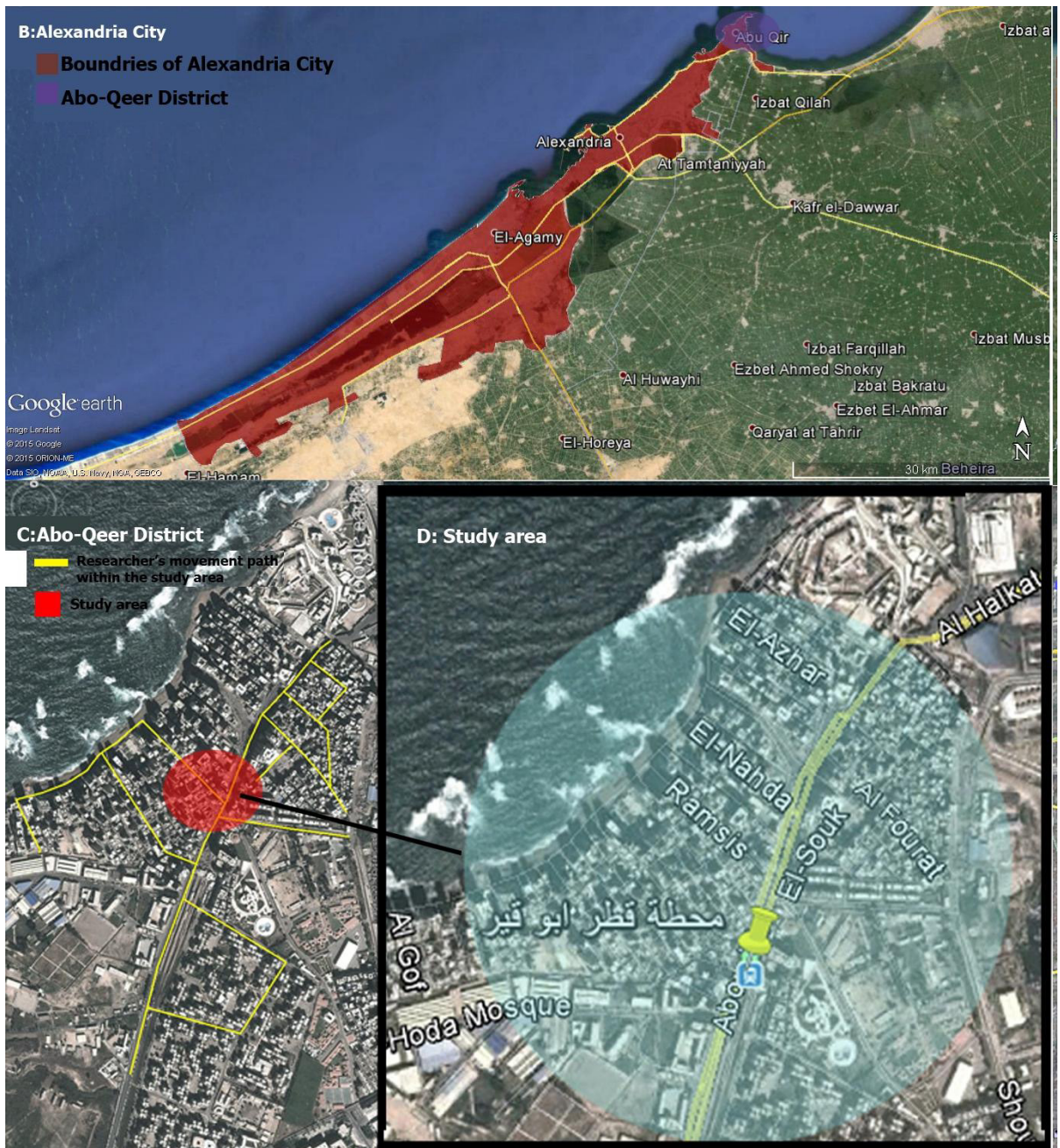


Figure 4: Illustration for the study area on four levels: country- city- district- zone, a: Egypt (continued)

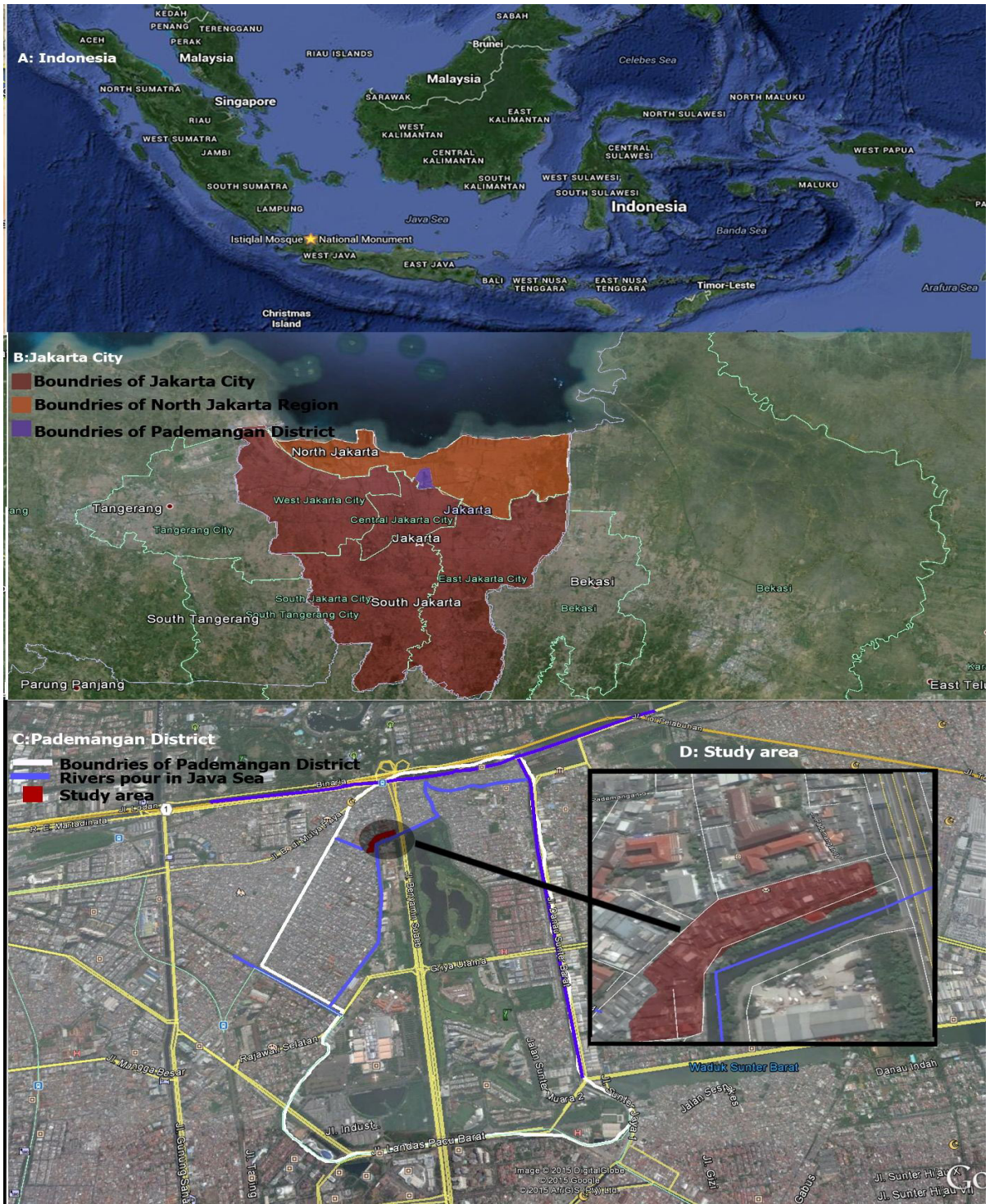


Figure 4: Illustration for the study area on four levels: country-city-district-zone, b: Indonesia

3. Why Choosing Flood Disaster?

Flood can be defined simply as: "A general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters from the unusual and rapid accumulation or runoff of surface waters from any source" (UN, 2010). From this definition, it could be recognized that it can happen from increasing rain causing flash floods -as in Abo-Qeer- and tidal waters -as in Pademangan-. Although periodic flooding is an essential characteristic of coastal zones (Blankespoor & Dasgupta, 2012), it is responsible for causing half of worldwide disasters and 84% of all disastrous death (Aon Benfield Americas, 2013). Hence, it was chosen as a catastrophic impact of SLR for this paper.

4. Methodology

In this section, the descriptive analysis of the sample, forming the proposed framework, data sources as well as data processing and analysis are presented.

4.1. Descriptive analysis

Number of population in Eastern Pademangan and Western Abo-Qeer districts are 44005 and 25784 inhabitant, respectively (Information and Decission Support Center, 2006; BPS, 2011). The sample size for the two zones are 449 and 267 people, respectively, who are representing the public sector, which are considered to be 1% of the population in each areas in both zones. Four stakeholder groups have been interviewed in both cities as shown in Table 1.

Table 1: Stakeholders whom have been personally in-depth interviewed by the researchers

	Type of Stakeholder			
	Government	Public sector	Private sector	NGO
Alexandria	- Directorate of Utilities and Housing -Coastal Research Institute representative -Shore Protection Authority representative	- Alexandria University (Staff member) - Leader of fishermen	- Fish shops' retail -Supermarkets' owner -Food maker retail	-Egyptian Red Crescent Society representative (Cairo and Alexandria branches)
Jakarta	-Urban Planning Department-Pademangan Sub-District Office representative -Post flood Department-Pademangan Sub-District Office representative	-Universtas Negeri Jakarta (Staff member) -Sub-community leader	- Stationary retail -Food maker retail owner - Gas station retail owner	-Indonesian Red Cross society representative (Jakarta branch)

Discriptive analysis for both samples which include gender,age and income is presented in Fig. 5.

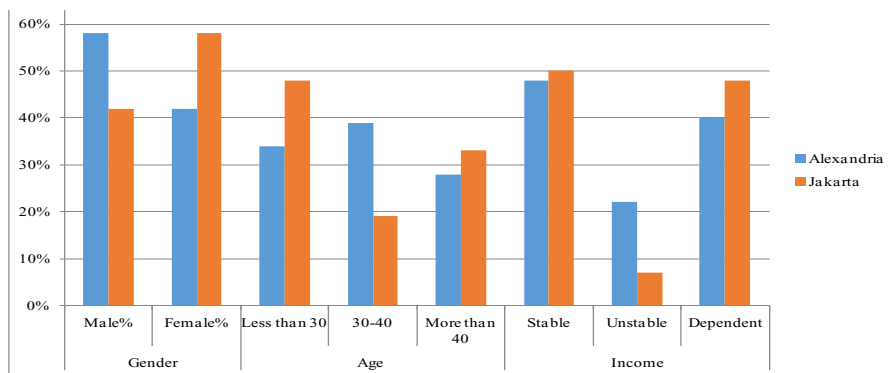


Figure 5: Descriptive analysis for samples of Pademangan, Jakarta and Abo-Qeer, Alexandria

4.2. Forming the proposed framework

As shown earlier in section 2.0, the community resilience against floods can be assessed by five different capitals: Natural, Physical, Social, Economic and Governance. According to Mayunga (2007); the notion of capital aligns very well with the concept of sustainability, which is related and often linked to the concept of disaster resilience (Tobin, 1999).The essence of using the capital approach is that, capital consists of Social, Economic, Human, Nature and Physical components, which are necessary for development of a sustainable community economy

Each of these capitals consists of a number of variables and each variable would have numbers of simple indicators. By addressing all variables and indicators of the above capitals, a framework is created depending on researchers' modifications applied to the Climate Disaster Resilience Index created by Rajib Shaw and IEDM Team (Shaw, 2009)and number of indices which conceptualize disaster resilience in the same way by focusing on similar factors that could increase community resilience against floods (Allan, Cottrell, & Goach, 2012; Jha , Miner, & Geddas, 2013) as shown in Table 2. In this table, capitals are colored in grey, variables are colored in yellow and indicators are colored in white.

Table 2: Proposed framework to measure FDRI’s five capitals

1- Governance		4-Physical	
G1- Mainstreaming of floods resilience		P1- Electricity	
G1.1	Existence of governmental institution that target the reduction of floods' impacts (Y/N)	P1.1	Accessibility
G1.2	Existence of regulations for land use and building codes target the reduction of floods' impacts (Y/N)	P1.2	Existence of alternative capacity
G1.3	Existence of city local strategies target the reduction of SLR impacts floods on people and city (Y/N)	P2- Water	
G2- Good governance		P2.1	%Accessibility
G2.1	%Effectiveness of government -community communication	P2.2	%Existence of alternative capacity
G2.2	Existence of the ability to access the governmental information related to floods (Y/N)	P3- Sanitation	
G3- Effectiveness of city's crisis management		P3.1	% Accessibility
G3.1	Existence of governmental disaster management structure (Y/N)	P4- Accessibility during floods	
G3.2	Existence of evacuation centers in the strategic plan (Y/N)	P4.1	%Accessibility of roads during floods
G3.3	Existence of financial resources for floods reduction (Y/N)	P4.2	%Efficiency of dams and bridges conditions
G3.4	Existence of flood early warning systems (Y/N)	P4.3	Existence of any mechanism of rain water draining (Y/N)
G3.5	%Trust in the governmental data transferred through the media	P4.4	%Accessibility to shelters in flood time
G4- Collaboration during floods with organizations		5-Social	
G4.1	Existence of city's dependency on external supporters (Y/N)	S1- Public participation in decision making	
G5- Knowledge dissemination and management		S1.1	%Population participating in activities
G5.1	Existence of awareness campaigns for floods held by the government (Y/N)	S1.2	%Trustfulness in representatives
2-Economic		S1.3	%Effectiveness of the local elections
E1- Employment		S1.4	% Ability to express needs
E1.1	Dependency ratio	S2- Education and awareness	
E1.2	%Unemployment	S2.1	% High Education level
E2- Household assets		S2.2	% Population awareness about flood disaster
E2.1	%Owners motorized vehicle	S2.3	% Awareness efforts received form from specialist
E2.2	%Owned homes	S3- Health	
E2.3	%House description	S3.1	%Accessibility to health facilities
E3- Finance		S3.2	%Existing medical alternative option
E3.1	%Income range	S4- Community preparedness	
E3.2	%Total income range	S4.1	% People have alternative food source
E4-Subsidy		S4.2	% People regularly check emergency supply

Table 2: Proposed framework to measure FDRI’s five capitals (continued)

2-Economic (continued)		5-Social (continued)	
E4-Subsidy (continued)		S5- Population	
E4.1	% Subsidy's type to pass the flood crisis time	S5.1	% Single families per home
3-Natural			
N1- Ecosystems services			
N1.1	%Quality of drinking water		
N1.2	% Quality of air		
N1.3	Existence of drainage in channels (Y/N)		
N1.4	Existence improper disposal (Y/N)		

4.3. Data processing and analysis

The methodology of processing and analyzing the data proposed in this paper derived from the climate disaster resilience literatures, particularly from the works of R. Show and IEDM team (APA, 2013) and J. Mayunga (Mayunga, 2007) . According to Mayunga’s work, there are many methods that can be used to construct an index, the basic difference is in the summation of the components of the developed index. A normalization method, commonly used, is the one which adjusts the observation to take a value from 0 to 1 (Briguglio, 2003) . After obtaining the normalized scores of each indicator, a transformation is needed to allow cross comparisons among two districts. This transformation is done by the “Min-Max” method as shown in Eq. 1, where E_{min} equals the minimum value for variable E and E_{max} equals the maximum value for variable E (Cross Validated, 2013). Finally, Radar diagrams are resulted from this .The closer the point is to the outer circle, the more flood preparedness is achieved.

$$Normalized(e_i) = \frac{e_i - E_{min}}{E_{max} - E_{min}} \dots\dots\dots \text{Equation 1}$$

In order to make the calculations easier, an assumption was made that all the dimensions/indicators have the same weight, due to the following: firstly, according to the previous mentioned literatures that all the capitals/indicators are important; therefore, no capital/indicator shall be favored in the final outcome of the FDRI; secondly, the calculation of the FDRI scores becomes more transparent and structured; and thirdly, to overcome having different types (yes/ no questions, usually/ sometimes/ rarely questions). Therefore, by using this assumption in the formula in Eq. 2- proposed by J. Mayunga (Mayunga, 2007), combining indicators to generate individual indices for each capital is done.

$$y_i = \sum(X_1w_1 + X_2w_2 + X_3w_3 + \dots X_nw_n) \dots\dots\dots \text{Equation 2}$$

Microsoft Excel software is used in order to compute the data in the proposed framework shown in Table 2.

5. Results and discussions

Overall, FDRI performance for both cities is represented in Fig. 6. The values in this diagram vary for both cities and are ranged from 1.2 to 9.7. As it can be observed from this figure that both cities have a high tendency to reach the best situation in the Governance Capital. However, for the Natural Capital, Alexandria city has a higher preparedness than Jakarta. In general, results showed strength and weaknesses in one capital or another. Table 3 illustrates justification and performance for both cities through the five community-resilience capitals. Each capital has two parts in this table, the upper part shows the performance represented by radar diagram and the lower part represents justifications for the results.

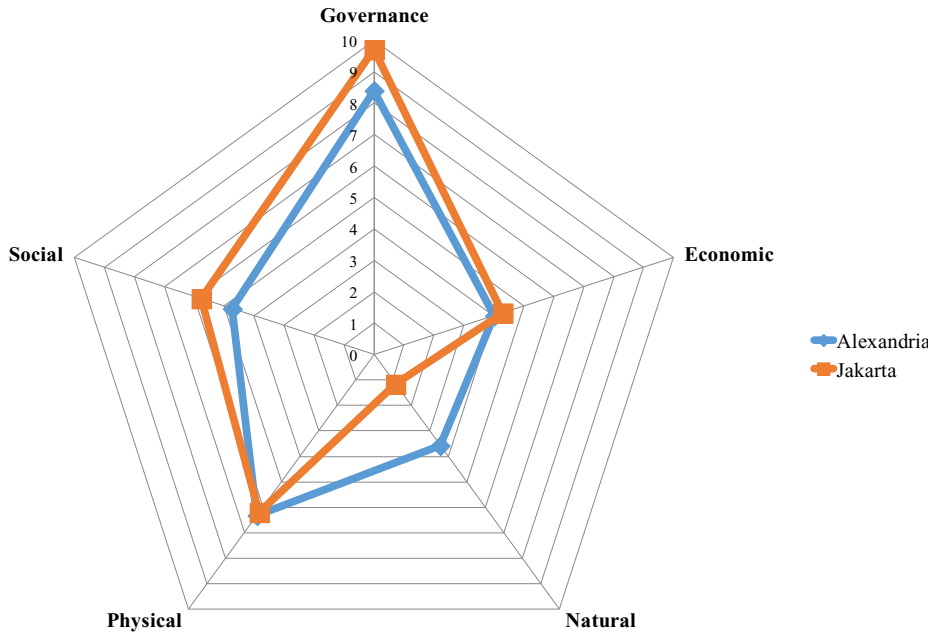


Figure 6: Overall performance for both cities through the FDR's five capitals

Table 3: Justifications for the FDR's five capitals

1-Governance Capital		
Alexandria	Jakarta	
Mainstreaming of floods resilience		
G1.1	Presence of Shore Protection Authority (SPA)	Presence of Post flood department for Pademangan sub-district
G1.2	Respecting the beach buffer (Abo-Bakr, 2014; Salwa, 2014).	Handling laws for evacuating settlements and turn these spaces into green belt (Waristo, 2013; Dharma, 2013)
G1.3	Periodic maintenance in Mohammed Ali Sea wall and raising level of sand ground. (Abo-Bakr, 2014; Salwa, 2014)	Building three pumps to raise the excess water from Anchol river to the Java sea and Increasing the depth of Anchol river and periodic maintained for Anchol's river water gate (Dharma, 2013)

Table 3: Justifications for the FDRI's five capitals (continued)

1-Governance Capital																													
	Alexandria	Jakarta																											
Good governance																													
G2.1	No existence for a local leader	Decentralization of the government in the Indonesia and Existence of success local leader (Dharma, 2013; Alamsyah, 2013)																											
G2.2	Existence of the ability due to the transparency between the selected governmental institutions and the individuals																												
Effectiveness of city's crisis management																													
G3.1	Existence of Egyptian National Committee for Disaster Management (Salwa, 2014; Waristo, 2013)	Existence of Indonesian Disaster Management Agency(BNPB)																											
G3.2	Existence of evacuation alternatives: move to another safe house (Abo-Bakr, 2014; Salwa, 2014)	Existence of evacuation alternatives :move to higher floors in the same house (Waristo, 2013; Dharma, 2013)																											
G3.3	Existence of Council of Ministries to SPA and Center of Research Institute (CoRI) (Abo-Bakr, 2014; Salwa, 2014)	Existence of Revenue and Expenditure Budget (APBD). (Waristo, 2013; Dharma, 2013)																											
G3.4	Existence of electronic sensors that keep recordings of the sea level [(Salwa, 2014; Dharma, 2013)																												
G3.5	Low performance of trust in governmental data due to instability of the political situation	High performance of trust in governmental data due to that the governor did what he promised in his election's program (Alamsyah, 2013)																											
Collaboration during floods with organizations																													
G4.1	Existence of international organization: World bank(WB) , Global International Finance (GIF), Red Crescent Institution (Salwa, 2014; Ayyad, 2014)	Existence of international organization : Australian Indonesian Facility for Disaster Reduction (AIFDR), United Nations Children's Fund (UNICEF) and Red Cross Institution (Waristo, 2013; Irma, 2013)																											
Knowledge dissemination and management																													
G5.1	No existence for flood-awareness campaigns (Abo-Bakr, 2014; Ayyad, 2014)	Existence of awareness campaigns resulted from cooperation between the government and the Indonesian universities (Alamsyah, 2013; Irma, 2013)																											
2-Economic Capital																													
<table border="1"> <caption>Data for Economic Capital Radar Chart</caption> <thead> <tr> <th>Indicator</th> <th>Alexandria</th> <th>Jakarta</th> </tr> </thead> <tbody> <tr> <td>E1.1</td> <td>0.6</td> <td>0.6</td> </tr> <tr> <td>E1.2</td> <td>0.1</td> <td>0.1</td> </tr> <tr> <td>E2.1</td> <td>0.1</td> <td>0.8</td> </tr> <tr> <td>E2.2</td> <td>0.1</td> <td>0.7</td> </tr> <tr> <td>E2.3</td> <td>0.6</td> <td>0.6</td> </tr> <tr> <td>E3.1</td> <td>0.4</td> <td>0.1</td> </tr> <tr> <td>E3.2</td> <td>0.1</td> <td>0.1</td> </tr> <tr> <td>E4.1</td> <td>0.7</td> <td>0.6</td> </tr> </tbody> </table>			Indicator	Alexandria	Jakarta	E1.1	0.6	0.6	E1.2	0.1	0.1	E2.1	0.1	0.8	E2.2	0.1	0.7	E2.3	0.6	0.6	E3.1	0.4	0.1	E3.2	0.1	0.1	E4.1	0.7	0.6
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E1.1	0.6	0.6																											
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E3.2	0.1	0.1																											
E4.1	0.7	0.6																											
Employment																													
E1.1	Rapid population growth leads to insufficient number of jobs available (The World Bank, 2014)																												
E1.2	Job opportunities have grown at a slower rate compared to the growth rate of population																												
Household assets																													
E2.1	High percentage for the owners of motorized vehicles due to that motorcycles are cheaper than cars																												
E2.2	The higher the percentage; the higher the ability to increase safe precautions for the house as the owner wants																												
E2.3	The higher the type of house; the higher the income level. Hence, the higher the ability to reduce floods' impacts																												
Finance																													
E3.1	The higher the income; the higher the ability to secure the home with important preparations to reduce floods' impacts																												

Table 3: Justifications for the FDRI's five capitals (continued)

2-Economic Capital (continued)		
	Alexandria	Jakarta
Finance (continued)		
E3.2	The higher the total income; the higher the ability to secure the home with important preparations to reduce floods' impacts	
Subsidy		
E4.1	The higher the percentage; the higher availability of side give subsidy to impacted houses	
3- Natural Capital		
Ecosystems services		
N1.1	People drink filtered tape water or directly from the tape due to lower pollution in water resources near district	
N1.2		Existence of high percentage of air pollution caused by the big number of motorcycles which force people to wear muzzles
N1.3	Activation for lows that organize drainage in the sea and rivers (Salwa, 2014)	
N1.4	Absence of waste disposal in soil affecting the selected zone (Salwa, 2014; Abo-Bakr, 2014)	
4-Physical Capital		
Electricity		
P1.1	Accessibility to electricity in Egypt: 9.6% (The World Bank, 2014)	Accessibility to electricity in Indonesia: 72.9 % (The World Bank, 2014)

Table 3: Justifications for the FDRI's five capitals (continued)

4-Physical Capital (continued)		
	Alexandria	Jakarta
Electricity (continued)		
P1.2	Occasion of electric cut off during floods .Hence, people aren't used to have alternative electric capacity	Frequent occurrence of electric cut off during floods .Hence, people are used to have alternative electric capacity.
Water		
P2.1	Accessibility to water in Egypt : 99.3% (The World Bank, 2014)	Accessibility to water in Indonesia : 84.9% (The World Bank, 2014)
P2.2	Existence of occasion floods. Hence, people aren't used to have alternative water capacity	Frequent occurrence of floods. Hence people are used to have alternative water capacity
Sanitation		
P3.1	Existence of sanitation networks. Although they sometimes during the floods they don't work sufficiently	Absence of sanitation network in the selected zone, People rely upon private septic tanks
Accessibility during floods		
P4.1	Existence of insufficient sewage drainage network lead to inaccessible roads during floods	Existence of sufficient rain drainage network lead to accessible roads during floods
P4.2	Equivalent score is taken from P4 4.1 duo to that both of the indicators have a common target.	Existence of some insufficient ooden/ concrete due to humidity and time
P4.3	Absence of rain water drainage system in the area	Existence of rain drainage canals beside houses and in the streets
P4.4	Existence of accessible shelters is higher	Existence of accessible shelters is lower
5-Social Capital		
<p style="text-align: center;">Social Capital</p> <p style="text-align: center;">Legend: Alexandria (Blue), Jakarta (Orange)</p>		
Public participation in decision making		
S1.1	Few community's activities	Various community's activities : collecting donations, recycled materials.
S1.2	Low sense of cooperation among the individuals	Participate to help raising the community's situation (Alamsyah, 2013)
S1.3	Low trust in the effectiveness of the community's representative whenever there is one	Local leaders' creditability and his communication with the government effectively (Alamsyah, 2013; Hendra, 2013)
S1.4		Trustfulness in the Jakarta's governor and governmental officers
Education and awareness		
S2.1	Lower number of unemployed with primary education or illiteracy	Higher number of unemployed and peddler retailers with primary education or illiteracy
S2.2	People's awareness is lower due to occasionally floods	People's awareness is higher due to frequent floods
S2.3	Lack of awareness campaigns (Abo-Bakr, 2014; Ayyad, 2014; Mohi, 2015)	Existence of awareness campaigns (Alamsyah, 2013; Irma, 2013; Hendra, 2013)
Health		
S3.1	Higher percentage can access health facilities due to low severe floods	Lower percentage can't access health facilities due to high severe floods

Table 3: Justifications for the FDRI's five capitals (continued)

5-Social Capital (continued)		
	Alexandria	Jakarta
Health (continued)		
S3.2	Tendency to keep first aid kit and other medical alternatives is more favourable	Tendency to keep first aid kit and other medical alternatives is less favourable
Community preparedness		
S4.1	Existence of mild short -period floods force less people to keep food	Occurrence of severe long -period floods force more people to keep food at their second floors
S4.2	Higher tendency to stay healthy force more people to regularly checking their emergency supply	Occurrence of seldom checking for the emergency supply
Population		
S5.1	Existence of higher percentage of single families per home due to current condition of social fabric for community in Abo-Qeer.	Existence of lower percentage of single families per home due to Current condition of social fabric for community in Pademangan.

6. Conclusions

Findings in this study showed that various types of vulnerability are found for each targeted city. Based on those differences, recommendations are provided to city governments and other stakeholders also differ. However, overall recommendations are converging to one goal: the enhancement of community resilience facing flood related disasters, hence, increasing its sustainability.

For Alexandria, intense interest should be given to aspects of the Social Capital as it's considered to be the lowest value among other values of the capitals. On the contrary, Jakarta has to apply intense interests to enhance the Natural Capital against floods- as it's considered to be the lowest value among the other capitals.

For the Governance Capital, more efforts should be done in the following fields: promoting awareness campaigns for floods impacts, held by the government specialists, and increasing communication effectiveness between government and community to overcome the shortage in the Governance Capital for both cities. However, for the Social Capital, innovative means of education and awareness tools will help in uplifting and renewing the existing current situation. Finally, efficiency of dams and accessibility of roads during floods need to be strengthened in order to address the shortcomings in the Physical Capital.

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