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ORIGINAL PAPER

Role of women as risk communicators to enhance disaster resilience of Bandung, Indonesia

Farah Mulyasari · Rajib Shaw

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Abstract This study addresses the need for women risk communication and highlights the potential role of Women Welfare Associations (WWAs) of Bandung, Indonesia, as risk communicators. A risk communication framework is modeled for women's risk communication process. A set of indicators in social, institutional, and economic resilience activities (SIERAs), with a scope of 45 activities covering three different disaster periods, were developed to characterize the delivery process of risk information by women in WWAs through their activities at sub-district and ward levels. The data were collected through a questionnaire survey method using the risk communication SIERA approach. Women's leaders at wards were surveyed concerning their perceptions on these 45 scopes of SIERA, ongoing activities, and their risk information source and dissemination process. Correlation analysis was applied to determine the relationship between the variables such as periods of disaster, types of activities (social, institutional, economic), and attributing factors (location, population, and education institution) in finding variations in risk communication activity that functions for women and communities. Five risk communication processes of WWAs are identified and implemented that work for women in Bandung. When their perceptions and ongoing activities are compared, activities such as dissemination of disaster risk information, conveying early warnings to their peers, and involvement of the local government have been confirmed to match the risk communication plans and implementation of WWAs. These indicate that WWAs' activities in Bandung implement a certain degree of risk communication that is embedded in their activities. The results confirm that women through their social networks can become active agents of change and thus act beyond their usual domestic roles and responsibilities in order to contribute to the overall enhancement of community resilience.

F. Mulyasari (✉) · R. Shaw
Graduate School of Global Environmental Studies, Kyoto University, Yoshida Honmachi, Sakyo-Ku, Kyoto 6068501, Japan
e-mail: farah.mulyasari@gmail.com

R. Shaw
e-mail: shaw.rajib.5u@kyoto-u.ac.jp

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1 Introduction

Disasters impact women differently than men. The high number of women casualties in the 1991 Bangladesh Cyclone (Begum 1993), in the 2004 Indian Ocean Tsunami, and in the 2004 Aceh Earthquake and Tsunami (Tanesia 2007; Prashar et al. 2012) has shown that women are more vulnerable to disasters. The higher vulnerability of women compared to men across all stages of disasters (before, during, and after) has been broadly documented (WHO 2005). The Beijing Declaration of Platform for Action (1995) highlights that environmental degradation and disasters often impact women more directly than men. In 2005, the Hyogo Framework for Action (HFA) of the UN acknowledges this difference. These were detailed in the section "Priorities of Action," which stated explicitly that a gender perspective should be integrated into all disaster risk management policies, plans, and decision-making processes such as risk assessment, early warning, information management, and education and training (UN-ISDR 2005).

Hydrometeorological disasters have doubled in the last few years, leading to a 50 % rise in extreme weather conditions associated with climate change from 1950s to 1990s (IPCC 2001; UN-HABITAT 2007). According to Sharma et al. (2011), many cities are experiencing the effects of increased storm intensity, flooding, water stresses, migration storms, and landslides that climate change brings. These impacts are growing threats to the present and future state of cities. There is a growing need to address this urgency through risk communication efforts for the public, especially women, spurring them to take enhanced resilience actions. In many cases, women receive little public information. Because of differing behavior patterns and preferences between men and women, women do not receive hazard warnings as much as men do in the community. The above-mentioned case of the 1991 Bangladesh Cyclone showed how women did not receive warning information directly as only men transmitted the information among themselves (Begum 1993; Genanet 2004). In more developed countries, the same tendency occurs as well. Takeuchi and Shaw (2009) described the effects of a sediment debris disaster in Hiroshima, Japan, where women became unwitting victims because disaster information targeted only the men who participated in community meetings and other networks. The disaster event occurred during daytime when husbands were at work and were unable to contact the women on time. Other factors such as poverty also contribute to women's disaster vulnerability. There was a death toll of women in the 1995 Kobe earthquake in which 3,294 women as compared to 2,199 men died. Also, 49.4 % of the 853 casualties from the Hurricane Katrina disaster were identified as women. The vulnerability of women to these disasters was due to inadequate housing indicative of the impact of poverty on disaster resilience (Takeuchi and Shaw 2008; Institute for Women's Policy Research 2010). Age is another primary factor as indicated by Sawai (2011) in which women above 80 years became victim of East Japan Earthquake and Tsunami 2011 in three prefectures (Iwate, Miyake, and Fukushima).

Bandung City is the capital of West Java province in Indonesia. It is the country's third largest city and second largest metropolitan area with a total population of nearly 2.5 million people and an annual growth rate of 1.81 %. Bandung, with an area of 167.67 km^2, has increasingly experienced floods since early 2000. The local government took up necessary countermeasures for flood risk reduction, yet the measures are more for

structural mitigation and do not directly address the communities' specific needs. What the community, especially the women, needs is a system of communication that contributes to their coping capacity for a more resilient community. Bandung's existing level of community resilience has to be measured and communicated widely, and this can be done through risk communication at the community level. Urban flood risk information at the local scale is one of the central issues. This information is necessary in order to assess the impacts of urban floods on city systems, and to develop suitable adaptation as well as mitigation strategies at the local level (Mulyasari et al. 2011).

Community resilience requires the need for Community-Based Disaster Risk Reduction (CBDRR) activities (Twigg 2007; Victoria 2009). Through CBDRR, communities can strengthen their capacities. CBDRR activities are implemented in Indonesia through Community-Based Society Organizations (CBSOs), which includes Women Welfare Associations (WWAs), Youth Unions, and Faith-Based Organizations (Mulyasari and Shaw 2012). Women Welfare Associations (WWAs) act as intermediaries for risk communication among women in Bandung. This paper addresses the need for women risk communication and highlights the potential role of women as a key agent in risk communication through WWAs. Firstly, this paper briefly describes resilience concepts, gender differences in risk perception, women's exclusion from risk communication networks, and the notions of women's empowerment and participation in risk communication to enhance the resilience. Then, the paper asserts the potential of women and WWAs in Bandung and the proposed model of risk communication. The SIERA methodology as a framework for analysis and data collection will be presented. Finally, the findings are presented and linked to the critical issues in women's risk communication.

2 Resilience, women, and risk communication

2.1 Resilience

Resilience and its related terminologies such as vulnerability, capacity, coping strategies, and sustainability must be understood and accommodated in risk communication. Twigg (2007) mentioned that in everyday usage, "capacity" and "coping capacity" often mean the same as "resilience." Twigg focused on the meaning of resilience of placing larger emphasis on what communities can do for themselves and how to strengthen their capacities. Moreover, Sapountzaki (2012) stated that regardless of the scientific field and context where the term is found, resilience is defined in two ways. Firstly, resilience is expressed as the opposite side of vulnerability. The relationship between vulnerability and resilience perceived as opposite to each other was also stated by Kasperson and Kasperson (2001) in Sapountzaki (2012). They stated that when the social system becomes vulnerable, it loses the resilience. Secondly, resilience is considered as a "process"-related definition. Sapountzaki (2012) defines resilience as "a process of self-organization and self-change in an attempt to retain essential functions or structure under the circumstances of whatever stress or perturbation." Other scholars like Cutter et al. (2008) explained that community resilience to disasters within hazards research is generally focused on engineered and social systems. It includes pre-event measures to prevent hazard-related damage and losses, which can be called "preparedness," as well as post-event strategies to help cope with and minimize disaster impact. Djalante et al. (2012) mentioned that the strong relationships of resilience with vulnerability and adaptive capacity could make its concept very relevant in the field of DRR.

Reducing disaster risk is about reducing the underlying causes of risks, which are closely related to vulnerability. However, increasing the resilience also means looking at what is available and accessible to individuals, households, and eventually communities and building on those existing capacities. Subsequently, Béné et al. (2012) explain how resilience relates to communication. The concept of resilience has a "pragmatic" advantage due to its relatively loose meaning, which is "the capacity to absorb shocks." It is confirmed with the fact that people, irrespective of their backgrounds and experience, work together based on the above meaning (Béné et al. 2012). Thus, the concept of resilience assembles a number of people, institutions, and organizations as it creates communication between disciplines and among communities as it offers common grounds through a dialogue. Resilience is closely related to sustainability. Folke et al. (2002) in Sapountzaki (2012) mentioned that resilience and adaptive capacities are seen as the key properties for sustainability. They concluded that being resilient is a main objective of sustainability and sustainable development. With disaster resilience in risk communication leading to sustainability in mind, how then can women contribute toward this aim?

2.2 Women's risk exposure, perception, and preparedness behavior

Gender issues are not always manifested in disaster-related crises. Yet, this is a prevalent assumption and is visible in the community, family, and individual levels in society. Due to gender differences, there are substantial differences on how men and women experience and deal with disasters and its phases (Ariyabandu 2009). Roles, responsibilities, and identities vary as a result of social interaction between men and women. Differing gender identity is a result of a combination of physical and behavioral characteristics (Ariyabandu 2009). Varying perceptions on gender lead to differences in roles, attitudes, actions, and even social position in the family and the community.

In order to understand the standpoint of women concerning disasters, scholars have identified women's exposure to different types of risks as well as women's perceptions and preparedness behavior. Women's exposure to risk, their social class, their role as primary caregivers, and their situation in developing countries are the identifiable key factors (Fothergill 1996). Other factors that exacerbate women's situation are their role in fulfilling childcare duties (Rivers 1982; Miyano et al. 1991; Millican 1993 in Fothergill 1996). Women are more exposed to disaster risk since they, as caregivers, have to stay with, assist, protect, and nurture their family members. And due to the lack of mobility and social isolation caused by poverty, women in developing countries have greater risk. According to the 1995 report of the United Nations Development Program, 70 % of the 1.3 billion people in poverty are women. Morrow and Enarson (1994) mentioned that women in poverty lacked status, power, and resources, which led to their risk in the disasters caused by Hurricane Andrew. Hamilton and Halvorson (2007) mentioned that women were also particularly most vulnerable in the 2005 Kashmir Earthquake in which the mountainous location exacerbated their high disaster risk.

Scholars noted that women and men differ in their worldview leading to a difference in risk perception (Cutter et al. 1992; Ho et al. 2008; Lachlan et al. 2009). While men are more focused on the specific technical aspects of protective measures against disasters (Szalay et al. 1986), Fothergill (1996) noted that women perceive disaster events more seriously than men, especially when there is a threat to their own family members. Women also show more concern toward man-made risks and environmental threats to health such as nuclear power and pesticides (Howe 1990; Cutter et al. 1992; Bord and O' Connor 1990 in Fothergill 1996). Lachlan et al. (2009) stated that the differences between men and

women are based on women's tendency to "see themselves as more vulnerable, having less control, and less likely to benefit from remedial action." Women tend to prepare their families and communities for disaster more than men, such as in the case of the disaster caused by Mt. Saint Helens when more women than men obtained additional information in order to protect their homes (Leik et al. 1982). Despite all of this, Takeuchi and Shaw (2009) noted that although women tend to perform preparedness activities, they are largely absent in more formal emergency preparedness activities. There is a need to identify the reasons as to why women, despite their tendency to be more prepared for disaster risk, tend to be excluded in disaster risk preparedness activities.

2.3 Women's exclusion in risk communication

During the 1991 cyclone in Bangladesh, the warning was only transmitted directly from men to other men (Genanet 2004; UN-ISDR 2009). Similarly, as previously stated, women were neglected during the debris movement in Hiroshima, Japan, because risk information was targeted toward men during community meetings (Takeuchi and Shaw 2009). In these cases, the husbands did not communicate the risk information to their wives, which led the women to fend for themselves. Why are women excluded in the transmission of disaster risk information? What are the reasons for their exclusion from the dissemination of public information? Anderson (2002) stated that the exclusion of women in risk communication bears economic impact. In Peru, the occurrence of El Nino was only transmitted to the fisherman while women were not alerted since they were not directly involved in fish catchment. This affected the family's household budget, which led to the realization that if women were also informed, there would have been better management of the household community.

The exclusion of women from risk communication creates a barrier for risk and disaster preparedness. The lack of timely and sufficient information not only hampers women's ability to take action but also denies them the opportunity to contribute to disaster risk preparedness. This leads to the worsening of women's social and economic status, resulting in more unequal gender relations (Ariyabandu 2009). In order for women rise up from this vulnerable position, women-sensitive risk communication must be strengthened and the imbalances and inequalities should be removed.

The role of risk communication is a crucial element in DRR efforts and is highly recognized by the UN. In 2005, the World Conference on Disaster Reduction adopted the Hyogo Framework for Action (HFA) 2005–2015. This emphasized the development of disaster-resilient nations and communities. The content emphasized the importance of early warning systems, people-centered participation, and timely and effective warning systems (UN-ISDR 2009). Positive action toward dissemination of risk information was encouraged in order for people to be able to help themselves and their own communities. However, despite this, the fact remains that women access, process, interpret, and respond to information differently from men. There is a need to address issues stated in the aforementioned cases as well as the way women participate in society (UN-ISDR 2009). A form of risk communication for and by women is fundamental in disaster risk reduction and management.

2.4 Women's empowerment in disaster risk communication

Women are more likely to receive risk communication due to their wide social networks and their tendency to provide protections. Women tend to hear and heed warnings from

their peers, neighbors, friends, and relatives more than men. Then women also tend to relay these warnings to their husbands. The influence of women can greatly contribute to the adoption of protective measures and hazard adjustments (Perry and Lindell 1986).

Gandelsonas (2010) stated that social networks are effective in communicating or transferring knowledge. This leads to a form of social capital, or shared meaning, which contributes to actions toward risk reduction and resilience building. Gandelsonas (2008) stated that when these social networks are based on gender, they could have a more positive social value and greater strategic significance in the communication of vital information. Members of these networks are the keys in offering support and providing access to local knowledge on various community issues. The social networks also provide a large membership base for consultation on various community issues plus a commitment to act.

Women's participation and empowerment in risk communication have not been extensively explored. The potential of women as risk communicators has been underutilized (Begum 1993; Khondker 1996). A few examples of women's empowerment in risk communication as well as their role in social networks have been described by the UN-ISDR (2009). These few cases are evidences of the strong potential of women as risk communicators within their own social networks. One example was mentioned in Oxfam documents (2007), which stated the case of Sahena, a woman in Bangladesh who organized a committee of women for flood preparedness. This committee teaches women how to build portable clay ovens, elevate their houses, and use radios to learn of possible floods or changes in climate, resulting in not only saving many lives but also empowering women in society. Women in Bangladesh also contributed to post-disaster emergency food relief. A study in Indonesia showed that through radio, women contributed to disaster information dissemination at the time of the flash flood in the South Sulawesi regencies (Tanesia 2007). Groups of women also contributed to the reconstruction of houses after the floods that occurred in North Pakistan in 1992 (Duryog Nivaran 1996). During this time, women relief workers assessed the needs of women and involved them in the planning and implementation of rehabilitation activities. Local women were registered as heads of their households to ensure efficient distribution of relief goods. Village women's organizations articulated women's needs and were responsible for community development. These are prime examples of how women through social networks were able to contribute to disaster risk communication, preparation, reduction, as well as post-disaster rehabilitation.

There is a need to understand the mechanisms underlying women and their social networks. Women's extensive and close-knit social networks play a significant role toward resilience, and they find government or official communications credible and trustworthy (Enarson 2009). Since women tend to participate in trainings and volunteer work for disaster preparedness programs (Nehnevajsa 1989 in Fothergill 1996), they can fulfill a leadership role among organizations concerning disaster issues. Women see disasters as a threat to their home and community that leads them to become active in these groups and extend their traditional domestic roles and responsibilities (Neil and Phillips 1990).

Through this paper, the authors aim to establish the potential of women and social networks such as the WWAs in Bandung for disaster risk communication. Takeuchi and Suzuki (2006), in their study on effective flood risk management, showed the importance of community groups in communicating risk. Newell (2001) and Wilson (2001) distinguished the differences in communication style between men and women. McKenna (1994) and Newell (2001) stated that women have the most effective communication skill because of their tendency toward shared communication and active listening. Enarson

(2009) highlights the participation of women in social networks as a key factor in disseminating vital information.

With these, the following sections establish the potential of WWAs in Bandung, through their social networks, in carrying out risk information dissemination to wider communities. This paper points out the role of women in WWAs as risk communicators. And tools adapted from Kikkawa's framework (1999) and women's DRR activities will be adopted, as an approach to and for effective disaster risk communication through the efforts women will be presented.

3 WWAs as potential risk communicators in Bandung, Indonesia

In highlighting women's risk communication as an important part of disaster risk management, how should the risk message be conveyed? To answer this question, an analysis on how women communicate disaster risk is conducted through a case study of Bandung. As mentioned earlier, the province is the densest populated region in Indonesia to which Bandung contributes approximately 2.5 million citizens. Bandung is divided into 30 sub-districts and 151 wards and is located in various topographies such as mountains, rivers, and plains. Bandung is described as a promising city with opportunities in business and has extensive administrative, commercial, and industrial activities as well as being the center for higher education (Bandung City Government 2009). These have contributed largely to its urbanization and results to a rapid growth in the city's population. Currently, the drainage system, which was initially built in 1810 (during Dutch colonialism), cannot accommodate a larger population and has led to the vulnerability of Bandung to disastrous events such as flooding. These underline the need for a disaster risk communication framework and raise the following questions: Who are at risk? What are the threats? Who are the stakeholders involved? What is the link between the senders and the receivers? By which media do senders and receivers interact? Women compose 49 % of the total population of Bandung of which 26 out of 30 sub-districts are usually inundated during high precipitation, with 68 locations identified by the Bandung Construction and Water Service (*Dinas Bina Marga dan Pengairan in* Bappeda Kota Bandung 2010). Women in Bandung, who are working in the field of industry, trade, and services, are exposed to the risk more than men by around 55 % (Bandung Statistical Agency 2011). When floods occur, women's activities are affected. The main goal of women's risk communication is to determine how the risks can be conveyed and addressed to the women and the wider community. In order to enhance the resilience of women and their community, women in WWAs with their social networks can convey risk information. Figure 1 shows the framework for women's risk communication as adapted from Kikkawa's risk communication framework. With women at the center of risk communication, they could act as intermediaries between their communities and the government as well as direct risk informants to other women and to wider communities in Bandung.

WWAs are key actors in community activities because they include most of the women in the families. Forty-nine percent of Bandung's population is composed of women, and some of them have an important role and a certain level of authority in the community. Women associations exist at the national, provincial, and local levels up to the lowest administration unit, the wards. Although the WWA movement is steered at the national level by the wife of the Minister of Home Affairs as head, the policies and programs are customized depending on the local context. The wife of the mayor heads of WWAs at the city level and WWAs in sub-districts are headed by the wives of sub-district leaders, and

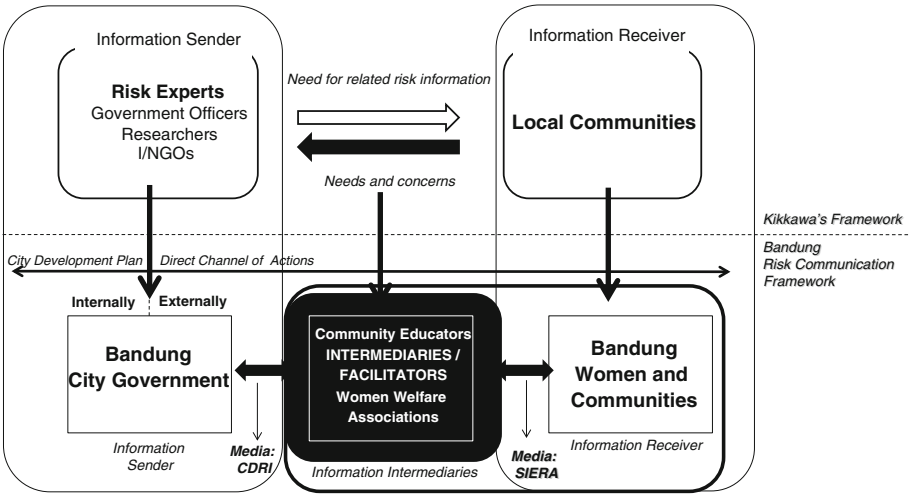

Fig. 1 Women risk communication framework for Bandung City

those of WWAs at the ward level are headed by the wives of the ward leaders. Since the Bandung City Government consists of 30 sub-districts and 151 wards, accordingly, there are 30 WWAs existing at the sub-district level and 151 at the ward level, which have direct link to women in the households at wards. The term of the WWA leaders terminates at the end of their respective husband's term.

Major activities of WWAs in Bandung are in the areas of economic empowerment, health, and to some extent direct disaster preparedness. WWAs in Bandung take the role in the community in organizing the community kitchen and training for community's flood preparedness and awareness. In one of the sub-districts, WWAs have regularly invited experts and organizations, such as fire fighters from the Bandung Fire Department and specialists from the local government, to conduct training. Another type of WWA involvement in disaster management is mobilizing and encouraging the community in volunteering to undertake actions when climate-related disasters occur. During the 2009–2010 flooding, WWA in *Cijerah and Caringin* wards in *Bandung Kulon* sub-district was actively involved in curbing waste disposal to adjacent rivers, monitoring water levels, disseminating up-to-date disaster information to communities, raising a budget for repairing river embankments to ward and sub-district authorities, and coordinating relief efforts with neighborhood groups and households. Because disasters pose a threat to their home and the community, women become active in these groups and have taken a role beyond those which are traditional (Neil and Phillips 1990).

4 Research methodology

4.1 Evolution of SIERA concept

This paper investigated the potential role of women in WWA in delivering risk information to women and communities and how it can be best implemented in a specific approach. At the initial stage of the approach, the Bandung City Government implemented a climate and disaster resilience mapping in November 2010 using the Climate-Disaster Resilience Index

(CDRI) method developed by Joerin and Shaw (2011). This resilience assessment looked at the five dimensions of resilience (physical, social, economic, institutional, and natural) and 25 parameters (5 parameters per dimension) and another 125 variables (5 variables per parameter). The aim of CDRI tool is to understand the resilience of communities, which is shaped by various aspects. CDRI has been applied in 36 cities in the Asian region, including Bandung City. As an example, Joerin et al. (2012) used the CDRI at Chennai City, India, where different resilience levels were identified through a quantitative approach. Based on the CDRI tool, the resilience dimensions that can be strengthened and implemented by WWA are social, institutional, and economic ones. Social resilience and economic resilience are the most determining factors of resilience that give the course of sustainable development. Social resilience is an important component in circumstances under which individuals and social groups adapt to environmental change. Adger (2000) states that ecological and social resilience may be linked through the dependence on the ecosystem of communities and their economic activities. Additionally, social resilience is fundamentally linked to the economic system in terms of its structure and distribution of assets.

Conjointly, referring to the definitions of resilience in Sect. 2, the "process-related" definition of resilience elaborated by Sapountzaki (2012) refers to ecological, social, and socioecological systems (SES). In relation to that, Folke et al. (2002) characterized one of the basic features or determinants of resilience attitudes, which is "the degree to which the system is capable of self-organization." The concept of self-organization is transferred to complex adaptive systems that have the potential to learn by experience, process information, and adapt accordingly. Stacey et al. (2000) refer to the term self-organization as "agents interacting locally according to their own principles or intentions in the absence of an overall blueprint of the system." It is the relation of resilience to theory that brings it very close to sustainability. Thus, social, institutional, and economic resilience activities (SIERAs), through DRR activities of WWAs, enhance the resilience in social, institutional, and economic dimensions and pave the way toward sustainability.

The SIERA approach is an attempt at extracting the women's perspective in mainstream DRR activities. Ariyabandu and Wickramasinghe (2003) point out that mainstreaming the gender perspective into disaster risk reduction put women as equal partners with men in the roles of decision-maker and beneficiary. Therefore, the SIERA approach is also the process of bringing women's perspective into mainstream activities of governments at all levels, as a means of promoting the role of women in the field of development by integrating women's values into development work and communicating risk and risk reduction efforts to the wider communities.

SIERA integrates these three dimensions and analyzes the DRR activities through primary indicators for different disaster phases (before, during, and after). To use SIERA in different disaster phases is important to describe women's coping strategies during the whole disaster cycle. McEntire (2001) emphasizes that a holistic approach is needed to the disaster problem and what is needed is an approach that addresses all agents and all actors, and all phases pertaining to disaster vulnerability. In this respect, the scope of SIERA approach sets then the course of DRR activities corresponding to three dimensions and 15 primary indicators. In total, there are 45 scopes of women's DRR activities that will describe the whole concept of the SIERA (Table 1). The dimensions and the primary indicators are adopted one by one from the previously mentioned CDRI dimensions and parameters (Joerin and Shaw 2011).

Subsequently, the formulation of the scope of DRR activities is based on literature review of women's issues as well as the preliminary field observation of CBSOs' activities

carried out in the communities in Bandung, like women's in WWAs, and based on the consultation with experts at regional and local level (WWAs at provincial, city, sub-district, and ward level). Indicated below are the linkages between the scopes and the literature concerning gender differences in risk management.

- Mobilization of other women in taking preparedness action (scope): The influence of women can contribute to the adoption of protective measures and hazard adjustments; the participation of women in social networks marks as a key factor in disseminating vital information (mentioned in Perry and Lindell 1986; Enarson 1998).
- Women relaying the early warnings (scope): Women are more likely to receive risk communication due to their social networks and their tendency to provide protections (mentioned in Perry and Lindell 1986).
- Provision of post-disaster's needs (scope): Women's organization articulated women's needs and was responsible for community development (mentioned in Duryog Nivaran 1996).
- Organizing and conducting training for disaster preparedness (scope): Women tend to prepare their families and communities for disaster more than men; women tend to participate in trainings and volunteer work for disaster preparedness programs (mentioned in Leik et al. 1982; Nehnevajsa 1989 in Fothergill 1996).
- Women's organization supporting women in securing the livelihood, providing access to resources, and finding alternative livelihood after a disaster (scope): Women in poverty lack status, power, and resources, which led to their risk in disasters (mentioned in Morrow and Enarson 1994).
- Women's organization gathering the disaster information (scope): More women than men obtain additional disaster information in order to protect their homes (mentioned in Leik et al. 1982).
- Involving women in decision-making processes through women's organization (scope): women have the most effective communication skill because of their tendency toward shared communication and active listening (mentioned in McKenna 1994; Newell 2001).

SIERA approach focuses on how Bandung's WWA conducts DRR activities to enhance the resilience of social, institutional, and economic aspects as described in the CDRI. It also obtains the risk perceptions of women and their communities (Mulyasari et al. 2012 in review). In addition, the dimensions and the parameters in the CDRI are tailored to Hyogo Framework for Action (HFA) and consequently CDRI facilitates the HFA (Matsuoka and Shaw 2011). Thus, SIERA likewise indirectly addresses the HFA. In summary, SIERA is an approach in conveying the risk and resilience information in social, institutional, and economic resilience manner through typical CBSO's activities identified in Bandung City such as women's groups like WWAs.

Following the SIERA approach presented in Table 1, a survey was conducted targeting the WWAs at the ward level in November 2010. The survey questionnaire was structured into two parts. The first part focused on the women ward leaders' perceptions of each social, institutional, and economic resilience activity according to the priority level based on a timeframe for each proposed activity (short term <2 years, medium term 2–5 years, and long term >5 years) according to each disaster phase. The second part stressed on their ongoing SIERA, out of 45 scopes of SIERA, which of those are being currently undertaken (ongoing). This study analyzed the role of women and their position not only as communicators of risk reduction in the community but also as communicators of potential risk. The survey was conducted with these women leaders due to their deep understanding of

Table 1 Dimensions, primary indicators, and scope of DRR activities in SIERA approach

Dimension	Primary indicators	Scope of DRR activities					
		Before disaster	SIERA code	During disaster	SIERA code	After disaster	SIERA code
Social	Population	Family planning	S1. B	Protection of vulnerable groups	S1. D	Provision of needs to vulnerable groups	S1. A
	Health	Health campaign	S2. B	Health care package	S2. D	Designing post-disaster health care packages	S2. A
	Education and awareness	Awareness and drill	S3. B	Emergency and early warnings	S3. D	Education and access to resources	S3. A
	Social capital	Decision-making process	S4. B	Mobilization	S4. D	Cultural event organization	S4. A
	Community preparedness	Training and courses	S5. B	Organization of vulnerable groups	S5. D	Responding to ongoing needs	S5. A
Institutional	Mainstreaming	Sensitizing disaster management plan	I1. B	Utilization of disaster management plan	I1. D	Review of disaster management plan	I1. A
	Crisis management	Training for volunteers	I2. B	Engagement of community leaders	I2. D	Data collection and communication to officials	I2. A
	Knowledge dissemination and management	Networking	I3. B	Networking	I3. D	Development of disaster awareness materials	I3. A
	Institutional collaboration	Linking government and cross-institution	I4. B	Disaster information gathering	I4. D	Disaster management forums and meetings	I4. A
	Good governance	Establishing early warning system with local government	I5. B	Inform updates to officials	I5. D	Reconstruction and rehabilitation plan	I5. A

Table 1 continued

Dimension	Primary indicators	Scope of DRR activities					
		Before disaster	SIERA code	During disaster	SIERA code	After disaster	SIERA code
Economic	Income	Training/courses	E1. B	Income security	E1. D	Support for finding alternative livelihood	E1. A
	Employment	Securing alternative livelihood	E2. B	Access to resources	E2. D	Women empowerment	E2. A
	Household assets	Introducing small-scale insurance	E3. B	Inventory of non- and destroyed household assets	E3. D	Mobilization	E3. A
	Finance and savings	Collective cooperative schemes	E4. B	Monitoring allocation of funds	E4. D	Microcredit and soft-loan system	E4. A
	Budget and subsidy	Sensitization of disaster risk management budget allocation	E5. B	Fundraising	E5. D	Linking local government in rehabilitation of education sector	E5. A

women's issues in disaster and their trust relationship with women and their surrounding communities. From these, insights into appropriate actions for preparedness and mitigation, emergency response, as well as reconstruction and assistance especially when a disaster occurs can be obtained. The study acknowledges certain limitation. Although the women's leaders of WWAs at the ward level can represent the majority of women's view in their communities, certain bias, limited understanding on certain issues, and different levels of uncertainty may exist in responding to the survey. Cross-checking with secondary data and personal interviews were done to address this issue. The study was conducted with support from the Bandung Planning and Development Agency, Health Agency, and WWAs at the city level. Primary data were obtained from the Women WWAs ward leaders' questionnaire survey as well as from focus group discussions with the head of Bandung WWA at city level, the Working Group Leaders, and WWAs Officers at some wards as key informants for secondary data. From a total of 151 wards, 119 women's ward leaders participated in the study.

4.2 Correlation analysis

Five out 45 scopes of the SIERA have communication elements (Table 2). The risk communication (RC) SIERA comprises a set of indicators that correspond to the risk communication activities done by women in WWAs. The indicators, which are included in the social and institutional dimensions, are meant to address the challenges faced by women in Bandung. Indicators such as education and awareness are crucial at the stage of predisaster. Disaster risk information should be accumulated and informed, which leads to disaster awareness. During a disaster, conveying and updating the situation enables women and surrounding communities to decide and take action. In terms of ward's effective crisis management, women in WWAs collect data of disaster-affected communities and deliver the data to the ward authority. Women contribute to good governance by participating in early warning activities. Hence, the promptness of warning and emergency information to women and surrounding communities can be understood. These have underlined that women in organizations are able to articulate women's needs and take responsibility for the community (Duryog Nivaran 1996).

A correlation statistic method with the benchmark score that is used in this correlation analysis is based on the correlation coefficient of higher than 0.7. It investigates the relationship between two variables of the scores between -1 and $+1$. The higher the score of the correlation coefficient (a maximum of $+1$), the high the degree of relationship between these two variables. The correlation method helps to identify the positive high degree of relationships between two variables, whether it is a relationship between each of the five risk communication SIERAs or whether it is the relationship between those RC SIERAs and the attributing factors. Those attributing factors are geographical locations, total population, density, and total schools, which feature the risk communication process. It identifies the following: whether women in different geographical locations are affected differently than in other locations, whether certain risk communication processes were carried out, whether the number of the population living in that particular ward can affect the risk communication process, or whether the total schools (or total formal education institutions) could possibly affect the risk communication process as well. It seeks the possibility of which types of risk communication strategies can be carried out, where, and what factors are attributing to make it work. This quantitative method has the aim to seek the microvariation types of risk communication strategies at the microcity level (the ward samples are aggregated into the corresponding sub-district). Once the risk communication

Table 2 Risk communication SIERA (RC SIERA) depicted from the SIERA approach

Dimension	Primary indicator	Disaster phase	RC SIERA	SIERA code
Social	Education and awareness	Before	Awareness and drills (Disseminating climate-related disaster awareness and conducting disaster drill at ward level for women)	S3. B
		During	Emergency and early warnings (Being attentive to emergency warnings and preparedness and communicating the information status effectively)	S3. D
Institutional	Effectiveness crisis management	After	Data collection and communication to officials (Collecting and communicating data of vulnerable groups to emergency teams and ward government)	I2. A
	Good governance	Before	Establishing early warning system with the local government (Advocating and cooperating with the ward and sub-district government in establishing early warning systems)	I5. B
		During	Informs and updates officials (Conducting systematic information gathering and dissemination of disaster losses to be shared with officials)	I5. D

strategies are identified, the next step would be to make them sustainable. The findings of the correlation analysis of the RC SIERA are discussed in the next section.

5 Research findings and discussion

The overall results are shown by the comparison of the perceptions and the ongoing RC SIERA of women's ward leaders with the same dimensions, indicators, disaster phase, and its scopes (Fig. 2). The results show that most of the WWA leaders at ward level (94 % women's ward leaders) perceive that advocating and cooperating with the ward and sub-district government in establishing early warning systems (I5.B/Good Governance/before disaster) has to be done prior to the disaster. The reason is that women prefer to establish a solid warning system such as developing inundation warning in advance before distributing the information, although in the ongoing activities they have done both activities in more or less equal proportion. Secondly, it also reflects that women find the government communications credible, as stated by Enarson (2009), when describing trustworthiness among women social networks. For this, the relationship between WWAs and Bandung City Government needs to be strengthened and sustained. These resilience activities in the social and institutional dimensions enhance the city's social and institutional resilience through CBSO's activities like WWAs. Collecting and communicating data of vulnerable groups for the emergency teams and ward government (I2.A/Effectiveness crisis management/after disaster) is perceived and undertaken equally (100 % of women's ward leaders in the category of RC SIERA perceptions and ongoing). This implies that although there is less literature on women's behaviors in emergency preparedness than on men's behavior, the case of Bandung WWAs confirms that women prepare their families and

communities for disaster and obtain additional disaster information in order to protect their homes more than men (Leik et al. 1982; Fothergill 1996).

5.1 Correlation between RC SIERA

The findings show that there is a significant relationship (level of significance of 0.7 and above) between RC SIERA S3.B and S3.D ($r^2 = 0.73$) (Table 3). It shows that disaster awareness and drills conducted by women at the ward level have a high relationship with the emergency and early warning scope. It implies that these two types of risk communication activities work in all 30 sub-districts and indicates that sufficient climate-related disaster risk information received by women leads to the enhancement of their risk awareness in conveying the appropriate early warnings. In addition, there is a significant relationship between RC SIERA I5. B and I5.D ($r^2 = 0.80$). It shows that establishing an early warning system with local government and informing the updates during disaster to officials interpret a strong collaboration between women in WWAs at sub-districts with local governments through this risk communication process. This should be considered as an asset to risk communication process that should be maintained by both parties (the WWAs and Bandung City Government). These results confirm what Neil and Phillips (1990) said concerning women perceiving disasters as a threat to their home and community leading them to become proactive toward risk communication (Enarson 2009).

5.2 Correlation between RC SIERA and its attributing factors

The correlation analysis between RC SIERA and its attributing factors such as different geographical locations, population (total population and density), and education institutions (total schools) is elaborated below and summarized in Table 3.

5.2.1 RC SIERA and geographical locations

A high degree of relationships between the RC SIERA and locations are shown in sub-districts, which are located in mountainous areas for the correlation between the RC SIERA S3.B and S3.D ($r^2 = 1$), RC SIERA S3.B and I5.B ($r^2 = 1$), RC SIERA S3.D and I5. B ($r^2 = 1$), RC SIERA S3.B and I5. D ($r^2 = 0.76$), RC SIERA S3.D and I5. D ($r^2 = 0.76$), and RC SIERA I5.B and I5. D ($r^2 = 0.76$). This means that women's activity of informing and updating the officials during a disaster has a strong relationship with the activity of establishing early warning systems with the local government, implementing emergency response and early warnings, as well as conducting awareness and drills. This implies that before updating women and community about the situation during a disaster, a certain amount of awareness, preparedness, and strong collaboration with local governments has to be capitalized first by women in WWAs, especially in vulnerable locations, such as mountainous areas. The next correlation results show that there is a significant relationship between RC SIERA S3.B and S3.D ($r^2 = 0.74$) as well as between RC SIERA I5.B and I5. D ($r^2 = 0.79$) among sub-districts located at the riverside areas. This shows that conducting awareness and drills lead women and communities to have received sufficient climate-related disaster risk information and enhance their risk awareness. Subsequently, it interprets that a strong collaboration exists between women in WWAs and the sub-district government in areas prone to floods. It implies that these types of risk communication activities should be further strengthened for flood risk reduction. Lastly, there

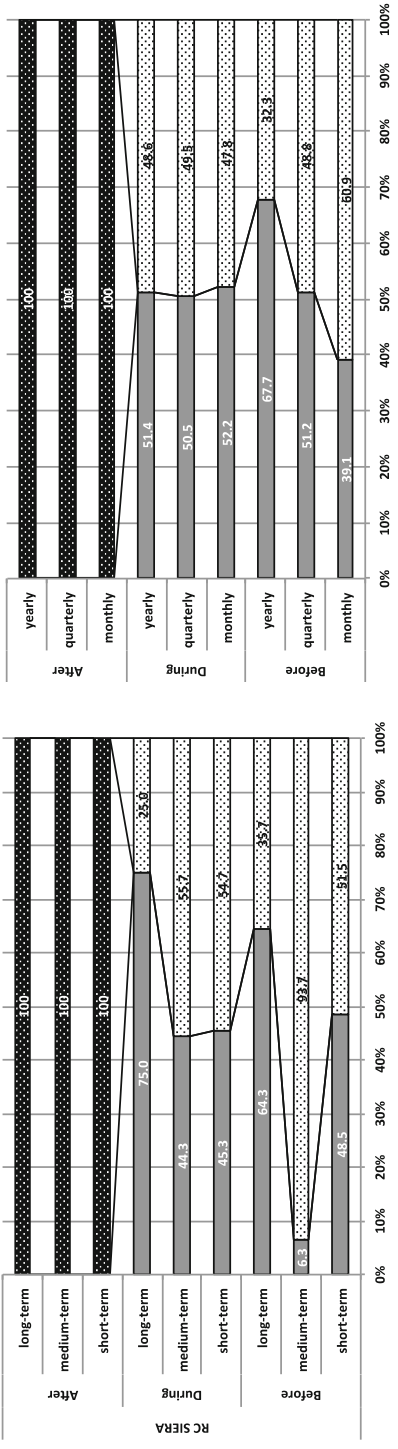

Fig. 2 RC SIERA perceptions (*left*) and ongoing RC SIERA (*right*)

Table 3 Correlation results of RC SIERA

	(Sub-district sample = 30)	Correlation coefficient				
	RC SIERA	S3. B	S3. D	I2. A	I5. B	I5. D
Awareness and drills	S3. B		0.73	0.44	0.55	0.53
Emergency and early warnings	S3. D			0.50	0.59	0.52
Data collection and communication to officials	I2. A				0.64	0.67
Establishing early warning system with local government	I5. B					0.80
Informs and updates officials	I5. D					
	Geographical location	Correlation coefficient				
	Mountainous $N = 4$	S3. B	S3. D	I2. A	I5. B	I5. D
Awareness and drills	S3. B		1	0.11	1	0.76
Emergency and early warnings	S3. D			0.11	1	0.76
Data collection and communication to officials	I2. A				0.11	0.56
Establishing early warning system with local government	I5. B					0.76
Informs and updates officials	I5. D					
	River $N = 27$	S3. B	S3. D	I2. A	I5. B	I5. D
Awareness and drills	S3. B		0.74	0.48	0.53	0.52
Emergency and early warnings	S3. D			0.54	0.59	0.53
Data collection and communication to officials	I2. A				0.67	0.68
Establishing early warning system with local government	I5. B					0.79
Informs and updates officials	I5. D					
	Plain $N = 26$	S3. B	S3. D	I2. A	I5. B	I5. D
Awareness and drills	S3. B		0.68	0.51	0.50	0.51
Emergency and early warnings	S3. D			0.57	0.54	0.50
Data collection and communication to officials	I2. A				0.73	0.68

Table 3 continued

	Plain $N = 26$	S3. B	S3. D	I2. A	I5. B	I5. D
Establishing early warning system with local government	I5. B					0.81
Informs and updates officials	I5. D					

	Total population	Correlation coefficient				
		Very low	Low	Medium	High	Very high
Awareness and drills	S3. B	0.01	0.10	0.06	0.05	0.53
Emergency and early warnings	S3. D	0.19	0.06	0.06	0.23	0.62
Data collection and communication to officials	I2. A	0.02	0.03	0.002	0.001	0.45
Establishing early warning system with local government	I5. B	0.01	0.14	0.14	0.05	0.77
Informs and updates officials	I5. D	0.02	0.14	0.35	0.21	0.66

	Population density	Correlation coefficient		
		Low	Medium	High
Awareness and drills	S3. B	0.20	0.03	0.02
Emergency and early warnings	S3. D	0.02	0.007	0.20
Data collection and communication to officials	I2. A	0.002	0.37	0.002
Establishing early warning system with local government	I5. B	0.03	0.007	0.003
Informs and updates officials	I5. D	0.0005	0.06	N/A

	Total schools	Correlation coefficient
Awareness and drills	S3. B	0.01
Emergency and early warnings	S3. D	0.11
Data collection and communication to officials	I2. A	0.03
Establishing early warning system with local government	I5. B	0.02
Informs and updates officials	I5. D	0.02

is a significant relationship between RC SIERA 12.A and I5. B ($r^2 = 0.73$) as well as RC SIERA I5.B and I5.D ($r^2 = 0.81$) in the sub-districts located at plain/low-land areas. This means that establishing early warning systems with local government is closely related to informing the updates during a disaster. This implies that solid and women-sensitive early warning system, especially in sub-districts that are usually inundated during heavy rainfall, has to be established with the support of local governments. These activities should be prioritized, enabling WWAs to convey proper risk information to women and communities in their areas. The results show that the influence of women can greatly contribute to the adoption of protective measures and hazard adjustments (Perry and Lindell 1986).

5.2.2 RC SIERA and total population

There is a significant relationship between RC SIERA and I5. B ($r^2 = 0.77$) and sub-districts that have a very high number of total population. This means that establishing early warning systems with the local government may become effective depending on the size of the population. This communication activity will go well for large-size populations, comprising various types of vulnerable populations (children, elderly, persons with disabilities, etc.). The result indicates a strong relationship of the above types of risk communication activities to the attributing factors, such as geographical locations and the size of the population. Knowing the size and locations of high-risk people in a certain jurisdiction facilitates effective risk communication outreach (Breakwell 2000; Breckjord et al. 2008).

5.2.3 RC SIERA and other attributing factors (population density and total schools)

The results of the RC SIERA correlation analysis with other contributing factors such as population density and total schools (such as formal education institutions) in sub-districts do not show a significant relationship. This implies that the density of people living in sub-districts and the level of formal education of women and communities in Bandung do not determine and prevail the risk communication process done by the WWAs.

5.3 WWAs' risk communication interface

Following the correlation analysis, an overview of WWAs of their risk information source is obtained. Based on the interview conducted in February 2012 with the Secretary of WWA of Bandung City, women in WWAs find the local authority, specifically those from the *Communication and Information Service* and a well-reputed regional newspaper (covering Bandung City and West Java) named *Pikiran Rakyat*, are the trustworthy sources. It shows that women put more value to city government and printed media as trustworthy and reliable sources of information on climate-related hazards and disaster risks, which confirmed Enarson's (2009) statement that women find government or official communications credible. Due to the unique organizational character of WWAs, where the leaders of women at the city, sub-district, and ward levels are the respective spouses of the mayor, the sub-district leaders, and the ward leaders, the women's leaders in Bandung have formed an effective working partnership with the local government. This is evident through the collaboration of WWAs with the local authorities, such as the Environmental Monitoring Body *(BPLHD Kota Bandung)* as well as the Communication and Information Service (*Diskominfo Kota Bandung*) of Bandung City to deploy and convey the

information in an easily understood language transmitted through FM Radio in conveying risk information to other women and communities. WWAs have made use of FM radio stations for conveying environmental and flood risk in the Green and Clean Campaign of year 2011 and 2012. The WWAs rank community activities first and mass media second, such as *Pikiran Rakyat* newspaper and *Rase FM* radio, for wider reach of risk communication.

The use of mass media is mainly for all communities (including women who work outside their home and are at the same time housewives who do not have much time for participating in women activities at their area). This shows how women in WWAs can act as the intermediaries for risk communication in Bandung. They have advanced their social networks and tools (i.e., women's activities and mass media) that may function as effective means to transmit risk information as raised by Gandelsonas (2010). Potentially, social networks based on gender can have a positive social value and a strategic significance in the communication of vital knowledge and information, as also argued by Gandelsonas (2008). Thus, the members of networks such as WWAs can be decisive in risk communication processes. WWs can offer their peers support and access to local knowledge and neighborhood contacts as well as provide a large membership base for consultation on various community issues. This substantially leads to a commitment to act on the risks.

6 Conclusions

The increase in the risks of climate-related disasters affects the vulnerable groups including women. Women's risk to disasters is influenced by gender differences in risk exposure, perception, and preparedness behavior; women's exclusion from risk communication; and women empowerment and participation in risk communication to enhance resilience. In addition, women's socioeconomic characteristics (health, disaster preparedness, household economic condition, etc.) and women's living environment (geographical locations and hazard prone areas) also contributed to women's vulnerabilities and risks to disasters.

This paper aimed to identify the types of risk communication activities conducted in Bandung and focuses on these processes in which women can act as risk communicators. Firstly, a risk communication framework was modeled for women risk communication process in Bandung. Secondly, a set of indicators categorized within the social, institutional, and economic resilience activities (SIERAs), with a scope of 45 activities implemented throughout three different disaster periods (before, during, and after), were developed to characterize the delivery of risk information by women in WWAs. The data were collected through a questionnaire survey using the SIERA approach by asking women's leaders at the ward level about their perceptions on these 45 scopes, ongoing activities, and their risk information source and dissemination process. Thirdly, a statistical analysis was applied to determine the relationship between the following variables: the period of disaster, the type of the activity (social, institutional, economic), and other attributing factors (location, population, and type of educational institution) in finding types of risk communication activity that work for women and communities. Through the qualitative as well as quantitative analysis, five risk communication processes were identified and implemented by WWAs for women in Bandung. These were (1) awareness and drills, (2) emergency and early warnings, (3) data collection and communication with officials, (4) establishing early warning systems with the local government, and (5) informing and updating the officials during a disaster. When their perceptions and ongoing activities were compared, several activities such as dissemination of disaster risk

information, conveying early warnings to their peers, and involvement of the local government have matched with their risk communication plans and implementation processes. The results show that WWAs' activities in Bandung's communities have already performed certain level of risk communication, embedded in their activities.

Responding to women's issues, in terms of gender differences in risk exposure, perception, and preparedness behavior, the correlation analysis of RC SIERA indicators S3.B and S3.D showed a significant relationship that implies that risk awareness of the women can be enhanced if sufficient climate-related disaster risk information is provided to WWAs before a disaster occurs. It entails that a broader partnership among WWAs and the city government of Bandung can bring greater participation of women in developing and disseminating information related to disaster awareness among women who are excluded due to the lack of mobility and social isolation. It will reduce the gap of gender perception about disaster risk due to the improvement of women's knowledge.

Similarly, in terms of women's exclusion from risk communication networks, RC SIERA analysis supports the global understanding of why good governance role is essential in enhancing community resilience. The correlation between I5.B and I5.D displayed a significant relationship and highlights high engagement of WWAs in advocating and cooperating with the ward and sub-district government in establishing early warning systems. This supports WWAs in conducting systematic information gathering and disseminating disaster loss information in their local areas to government officials. It signifies that information associated with the climate-related hazards through early warning systems would be disseminated to the most vulnerable section, especially to women in Bandung City through the WWA networks. As a result, women can take proper actions to overcome their physical barriers before and during disasters. Thus, cooperation among local government in the districts and sub-district levels with the WWAs for the establishment of early warning system will also address the issues of women exclusion from communication networks. Finally, women can be empowered in risk communication through WWAs and through the use of the RC SIERA approach. These provide women a platform to interact and a commitment to act with the local government in enhancing their resilience. In addition, the support of mass media (newspapers and FM radio stations) can enable WWAs to take and make decisive actions. This situation has led women in Bandung through WWAs to act beyond their usual domestic roles and responsibilities.

There are limitations concerning the RC SIERA approach. Although different areas, different cities, or even different regions and countries have women's organizations, each might not share the same scope of SIERA that was indicated in this paper. Therefore, the scopes of SIERA have to be identified and adjusted in advance before utilizing it in different contexts. Another limitation of RC SIERA is that due to different factors such as the varying size of vulnerable population and their geographical locations of sub-districts and wards, it might not cover their same needs and priorities. Thus, further research must be completed on how to incorporate their specific priorities and needs using the RC SIERA approach to address women's various demands and perspectives.

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