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Managing Early Warning Systems for Tsunami Prone Communities: Preliminary Analysis of the Needs for Participatory Approach (PRA)

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Synopsis

This paper describes the needs for Participatory Approach in Managing Early Warning Systems in tsunami prone communities. Several research issues related with local communities and early warning systems are identified. Six characteristics of PRA considered as a promising assessment method for participatory approach are used as a framework of this preliminary analysis, and it is applied to assess the needs and suitability in the context of EWS. This paper concludes by discussing some further research efforts to be made so as to examine the applicability of the proposed approach in real case study fields.

Keywords: community, tsunami, early warning system, participatory approach; PRA

1. Introduction

After the last major tsunami in the Indian Ocean, December 26, 2004 tsunami early warning systems have been realized as a very urgent issue to be installed in the Indian Ocean. Nevertheless the issues of early warning systems (EWS) should address not only the installation of the technology of early warning systems but also the process of disseminating EWS to people who are endangered by tsunami disaster. EWS also assumes that the right evacuation way properly functions when a disaster occurs.

In relation to the dissemination of EWS, this paper discusses the importance to develop an appropriate implementation of knowledge and technology in managing EWS for tsunami prone communities. Since the implementation of knowledge and technology is better achieved with the involvement of multi-stakeholders. That is, social co-learning among the stakeholders is expected to be achieved in advance. It is expected that when a tsunami occurs, the EWS already installed will be understood clearly by users, notably the residents of communities. It is also hoped that the communities who are endangered by disasters will know how to act and will be able to evacuate in an effective and quick way.

This paper has been written based on a literature review of several research studies in early warning systems. Cases in Japan and in Indonesia are also discussed to develop a better picture of implementations of warning systems.

In general, this paper discusses three aspects. *First*, the dissemination process of early warning systems, applications of EWS in Japan and Indonesia and the relevance with local knowledge. *Second*, it briefly discusses the theory of participatory approach with reference to Participatory Rural Appraisal (PRA). *Third*, the paper discusses the needs of PRA in the context of EWS and how PRA can be applied to increase the quality of the dissemination process of EWS. Finally, it addresses the lessons learnt and the possible ways of improving implementation of EWS.

2. The Dissemination Process of EWS

By definition, early warning system is *the provision of timely and effective information, trough identified institutions that allow individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response* (ISDR, 2006b). Additionally, a broader definition of early warning was discussed at the 2nd international conference of early warning in Shanghai: "*An EWS is a social process for generating maximally accurate information about possible future harm and for ensuring that this information reaches the threatened by this harm, as well as others disposed to protect them from the harm*" (Glantz, 2004). Warning systems detect impending disaster, give that information to people at risk, and enable those in danger to make decisions and take action (Mileti, 1999). Moreover warning systems are complex, because they link many specialties and organizations – science (government and private), engineering, technology, government, news media and the public (Sorensen, 2000). As an addition, Samarajiva (2006) argues that the problem with tsunami warnings are 75% false and those false warnings are costly.

What type of early warning that the society need? To answer this question, this paper describes a review based on previous literature studies in this field. Glantz (2004) on the report of 2nd EWS conference notes EWS should fit the needs of the society and the groups or regions at risk to hazards of concern. He proposes that early warning system must address the five Ws: what, when, where, who and why. What is happening with respect to the hazard(s) of concern? Why is this a threat in the first place, i.e., what are the underlying causes for potential adverse impacts? When is it likely to impact (providing as much lead time as possible to at-risk populations). Where are the regions most at risk? Who are the people most at risk, i.e., who needs to be warned?

Additionally, Wisner (2005) raises issue related with early warning system on his paper "Is warning good enough". Furthermore, this issue is related with one of the concerns, which is the sustainability of warning systems. The question of sustainability comes up in planning for an Asian tsunami early warning system because tsunamis are not that common disaster in the Indian Ocean. As a follow up, Wisner (2005) suggests that tsunami early warning system can be combined with systems set up to warn for the other types of hazard in order to maintain the awareness of tsunami as well as to reduce the cost.

Basher (2006) argues there are four elements of effective EWS: the assessment of risk, the technical warning service, the communication needs and the preparedness of those at risk (figure 1). Basher models underlie the parts of the warning system, such as the likely impacts of a hazard, the way warnings are communicated and acted on, and the dynamics of evacuation processes.

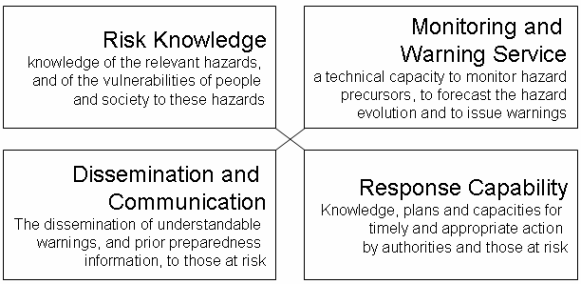

Fig.1 The four elements of systematic people-centred early warning systems (Basher, 2006)

Failures in early warning systems typically occur in the communication and preparedness elements (Basher 2006). Informing the population, its perception of potential risk, and the efficiency of local administration are factors that determine, to a great extent, the scale of after-effects of natural calamities. In the case of Nevado del Ruiz Volcano, it was the lack of adequate perception of the degree of risk on the part of both the population and the local administration that caused the deaths of 23,000 people in Columbia during the eruption (Kondratyev et al., 2002).

In the following discussions, TEWS in Japan and Indonesia respectively are discussed and as addition, the relationships of dissemination process of EWS with local knowledge are discussed as well.

2.1 EWS and Local Community

There have been emerging concerns to increase community disaster preparedness. Several research studies have provided some useful insights on this matter as follows. There are some key issues identified in the relation between EWS and local community including: familiarity with EWS, local knowledge, education, failure of response, low cost technology and local participation and collaboration between local community and researchers. Those key issues are discussed as follows.

Familiarity with EWS does not mean a high level of understanding. Gregg et al (2006) assessed public understanding of the sirens and the meaning attributed to

siren surrounding in Hawaii related with tsunami disaster. Relationships between awareness of siren testing, test frequency, length of residency in Hawai'i and understanding of the meaning of the sirens were examined. They concluded that familiarity with the routine system siren tests and test frequency and length of residency in Hawai'i have not influenced greatly on the levels understanding on the meaning of the siren (Gregg et al. 2006a). It is important to incorporate disaster preparedness with the event of disaster that happens in the other areas, i.e.: Sumatra Earthquake in 2004 could be an adequate event used to remind people of possible disasters in the future. This is expected to people's awareness.

Recently an earthquake happened in Padang with Magnitude 6.4 Richter Scale on March 6th 2007. At least 70 people killed, hundreds injured and severe damage in the Bukittinggi-Solok-Payakumbuh, West Sumatra, Indonesia (USGS, 2007). According to Kogami (Komunitas Siaga Tsunami – Tsunami Prepared Community), this event caused people to become more afraid of disaster. On the other hand, this has increased community's willingness to participate in disaster education and disaster drills (Kogami, 2007).

While in Japan, as recent concerns are related with future Tokai-Tonankai Earthquake, some smaller events of earthquake are suggested as good lessons learnt such as Niigata Earthquake in 2004 and many other smaller events. These cases help to let the communities getting more aware of earthquake disaster.

Local knowledge in concert with a thoughtful education plan and appropriate geography can go a long way toward mitigating the hazards in areas that are closest to the tsunami source. Furthermore, (McAdoo et al., 2006) provides an example from communities living in Simeulue Island, which is located close to the epicenter of earthquake that caused tsunami Aceh in December 2004. Those local communities were isolated from high-tech communication and warning system had been able to evacuate and run away before tsunami hit the coast.

Education on disaster preparedness promotes awareness in the communities. Johnston et al (2005) were concerned with quantifying people's understanding of tsunami hazards on Washington coast, their knowledge regarding the Washington State tsunami warning system, their preparedness to deal with tsunami activity, and providing information that could be used for baseline measurement. They found that hazard education program has been successful in terms of promoting awareness of and access to information about tsunami hazard among coastal Washington residents. Nevertheless, despite success in disseminating hazard information, levels of preparedness were recorded at low to moderate levels.

In fact, warnings often fail to induce the desired response because the language of the warnings may be too technical or in an inappropriate format to be understood by communities of various backgrounds. This is commonly due to lack of participation of the community, the media and other stakeholders in the planning and development of the warning-response strategy (ISDR, 2006a).

Low-cost technology and local participation can also provide significant results in early warning. La Masica municipality, in the Atlantida province of Honduras was the example for this (Wisner, 2005). The reason was that an early warning and risk management project, with the full involvement of La Masica's inhabitants, had been initiated a couple of years prior to Mitch. With collective memories of the impacts of hurricane Fifi in 1974 and a series of other serious flooding incidents since then, the population of La Masica had sought to improve their preparedness and planning for such events (Wisner 2005). To improve the chances of successful implementation, the main features of plan should be low cost, low technology and high local involvement (Cronin et al., 2004). In addition, the type of the system can also be linked with cultural memory of local people as the basis to form the local low-cost monitoring methods.

Kelman (2006) reviews that in order warning system (for tsunamis and other events) to be developed, implemented and maintained successfully, the warning system needs to be planned as integrated components of the communities.

Collaborations between researchers in multidisciplinary fields and with local communities also take important roles. Ronan et al (2000) discusses the multidisciplinary, research-based collaboration that has evolved following initial work examining the social impacts of the 1995-1996 eruptions at Ruapehu volcano in New Zealand. Their finding reveals the collaboration between physical and social scientists in multidisciplinary team plays a key role in reducing the social impact of volcanic hazards through assisting the communities, organizations, and individuals following an eruption and related research (Ronan ed et al, 2000). Additionally, Cronin et al (2004) in two cases in Savo, Solomon Islands, and Ambae Island, Vanuate provide

examples of good collaboration with the local communities.

People may not be motivated to prepare if they do not perceive natural hazards as critical or salient issues within their community (low critical awareness – about natural hazards themselves and/or in relation to other issues such as crime or unemployment) (Paton, 2003). Motivation to prepare could also be affected because hazard anxiety reduces risk acceptance and encourages avoidance of information relating to risk reduction and readiness. Even if motivated, people may not formulate intentions if they perceive hazard effects as insurmountable (low outcome expectancy) or do not perceive themselves as having the competence to act (low self-efficacy) (Paton, 2003).

It is possible to incorporate academic knowledge with local and traditional views for volcanic hazard assessment and management (Cronin et al. 2004). In addition to that, Cronin et al note that workshops play important role in order to get all appropriate stakeholders and aim for maximum inclusion. Participatory Rural Appraisal (PRA) methods are considered to be the best methods to take account the large differences in education levels, roles, political agendas and status/power within the workshop focus group (Cronin et al. 2004). Therefore, it is argued that PRA can serve as a bridge in implementing the dissemination process of EWS.

2.2 Tsunami EWS in Japan

In Japan, Japan Meteorological Agency (JMA) is responsible to issue the early warning in case of disasters, such as tsunami or earthquake happen. In the case of tsunami, in particular, JMA will issue the EWS within three minutes after an earthquake happens. The scheme of how early warning disseminated is shown figure 2. Initially it will start from the observation of an earthquake. JMA calculates the possible tsunami induced by a particular earthquake and picks the similar possible events based on previously calculated numerical modeling (JMA, 2007). If there is a high possibility of tsunami, then the information is disseminated to the public through the assistances of local government, police and fire offices, broadcasted television channels and radio stations.

The residents will receive the information throughout several means, such as: loudspeakers / sirens near the coastal areas, televisions and radio. Additionally, in coastal areas in Japan, many signs of tsunami evacuations have been put in visible places so that it makes it easy to understand where to escape in case of tsunamis.

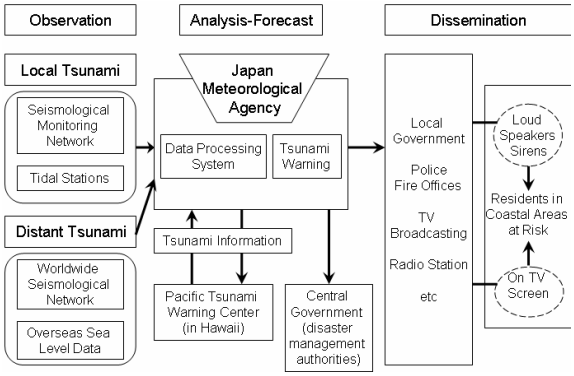

Fig.2 Tsunami Warning Dissemination Process in Japan (Source: JMA, 2007)

JMA in Japan has existed for a long time and concerns for disasters have been throughout the history of the country which is prone to earthquake and tsunamis.

Several initiatives related with tsunami warning system and risk communication have been conducted in Japan with one of distinct cases is one that has been being carried out in Owase City (Katada Laboratory, 2007). In this case, researchers from Gunma University have developed excellent interfaces using personal computers as a means for communications with local governments and local residents.

2.3 Tsunami EWS in Indonesia

In Indonesia, Badan Meteorologi dan Geofisika (BMG) or Indonesian Meteorology and Geophysical Agency is responsible to issue an early warning in case a disaster happens. In contrast with Japan, Indonesia has just developed a thorough disaster warning systems. This system has not yet been rooted in the societies all over the country. As a result, some early warning systems have indicated failures in its implementation, for example: the case of Tsunami in Pangandaran that happened in July 2006, nearly two years after Tsunami in Aceh, still claimed almost 1,000 people's lives. According to some medias (BBC, 2006), there was an ambiguity in BMG, whether it was necessary or not to issue and early warning.

In Indonesia, Padang City is one of good examples in preparation for tsunami (see figure 3,

location of Padang City). Induced by event of Tsunami in Aceh in 2004, this city has been leading promotion of tsunami warning for residents living in its coastal areas. In Padang, there has been an NGO that has been established to inform and empower local people, especially who are living along the coastal areas of Indian Ocean. Their activities mainly in provide education and raise awareness of local communities against tsunami disaster. The other city that has just started the installation of tsunami EWS in Indonesia is Bali.

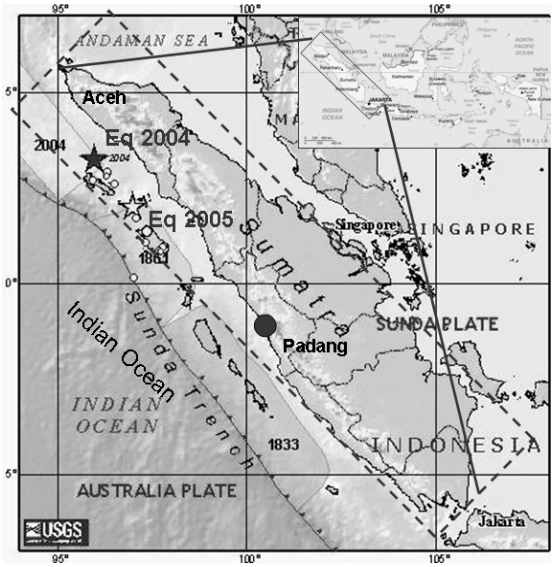

Fig.3 Location of Padang City, Indonesia (Source: USGS)

Nevertheless, until now there is no clear (official) explanation of how the dissemination process of tsunami warning in Indonesia. Pribadi et al (2006) conducted surveys to several governmental agencies in Indonesia and could conclude the tsunami dissemination process in Indonesia (figure 4). In Indonesia, the tsunami warning dissemination process starts from Indonesian Meteorological and Geophysical Agency or *Badan Meteorologi dan Geofisika* (BMG). The tsunami numerical simulation is planned to be helped through the project of GITEWS (Germany Indonesia Tsunami Early Warning Systems). In the case of an earthquake in coastal areas, BMG will inform media, police and army and local governments. The next step is the process to pass information obtained from BMG to local communities (figure 3). Nevertheless, as mentioned earlier, the preparedness in the local community has not been measured well yet.

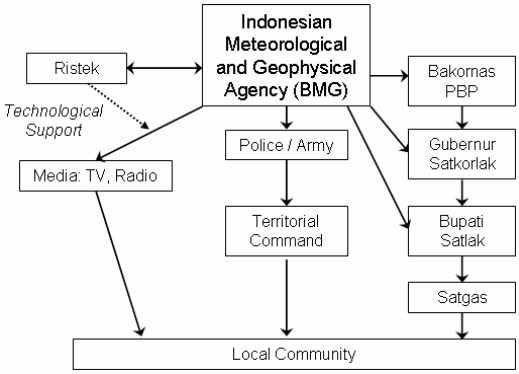

Fig. 4 Tsunami Warning Dissemination Process in Indonesia (Pribadi et al, 2006)

Figure 4 does not clearly describe how the local communities in Indonesia could fully utilize the information of warning system given to them. In particular many coastal areas in Indonesia are located in remote areas which are far from the big cities. As a result communication systems in some places are still poor. This causes a problem when there is a need to disseminate the warning to those who are in need. This problem can be addressed by involving the local communities in establishing the EWS.

Additionally, Pribadi et al (2006) identified that currently there is no such an agreed operational tsunami warning system (chain) available. The primary concern includes on how to develop a comprehensive understanding and commitment toward the need to develop an operational and integrated tsunami warning chain as part of disaster warning mechanism.

3. Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) is a growing family of approaches and methods to enable local people to share, enhance, and analyse their knowledge of life and conditions, and to plan, act, monitor and evaluate (Chambers, 1994). PRA consists of participatory mapping and modeling, transect walks, matrix scoring, well-being grouping and ranking, seasonal calendars, institutional diagramming, trend and change analysis, and analytical diagramming (Chambers 1994). The use of each method is context and case based. This means that not all approaches are applied at the same time and activities.

Many fields that have implemented PRA include natural resources management, agriculture, poverty and social problems, health and food security and local

governments (Chamber 1994). Commonly, the uses of PRA are widespread and can be found in less developed countries where senses of community are still closely connected each other, i.e.: in India, Nepal, Sri Lanka, Philippines, Indonesia and other African countries. Nevertheless, the uses of PRA in more developed have been emerging and significant, i.e.: England and Switzerland (Schmidt, 1996).

In the field of disaster management still only a few cases of PRA can be found, mainly in producing hazard maps, for example Cronin et al (2004) with cases in Solomon Islands and Lolovange, Republic of Vanutu Islands. In those cases, the methods of PRA were employed to acquire local knowledge in making hazard maps, evacuation plans and warning systems.

Based on well-known literatures of PRA, written by Chambers (1994), PRA is distinguished by a shift of paradigm, notably a shift of six characteristics: *from etic to emic*, *from individual to group*, *from verbal to visual*, *from measuring to comparing*, *from reserve to rapport*, and *from extracting to empowering* (figure 5). In each discussion of the following characteristics, the relationships with EWS are also presented.

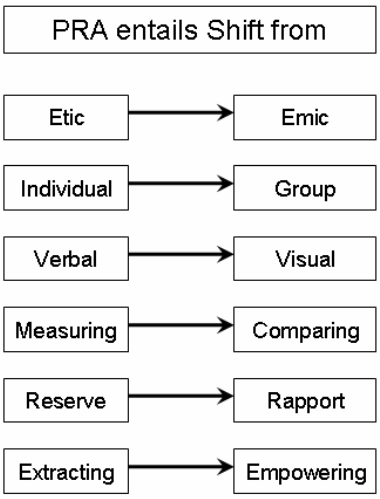

Fig.5
Characteristics of the Paradigm Shift of PRA
(Source: Chambers, 1994)

3.1 From etic to emic

From etic to emic is a move from the knowledge, categories and values of outsider professionals to those of insider local people (Chambers 1994:1262). The reversal from etic to emic has, then, to be from closed to open. In PRA methods such as participatory mapping and modeling, matrix ranking and scoring, Venn diagramming and well being ranking, insiders can be even more in charge of the agenda and detail, not only free to express their knowledge and values, but encouraged to do so.

3.2 From Individual to Group

In PRA, discussions with individuals can and do take place, but there is more attention to groups and participatory analysis by groups. Groups can have disadvantages, such as dominance by one person or a vocal minority. But their advantages have been undervalued. Typically, they have an overlapping spread of knowledge which covers a wider field than that of any one member (Chambers 1994).

3.3 From Verbal to Visual

With traditional questionnaire surveys and semi structured interviewing, most of the transfer or exchange of information is verbal. This contrasts with the visual mode of participatory diagramming. This includes social and census mapping, resource mapping and modeling, seasonal analysis, Venn diagramming, trend diagramming, matrix ranking and scoring, and time use analysis, and is often a group activity.

With visual analysis, relationships change. The topic may be determined, or at least suggested, by outsider, but the role is not to extract through questions but to initiate a process of presentations and analysis. Visual methods can also empower the weak and disadvantaged. Visual diagramming is thus an equalizer, especially when it is done using the accessible and familiar medium of the ground. The shift from verbal to visual is one of emphasis in PRA. Diagrams are part of the repertoire (Chambers 1994).

3.4 From Measuring to Comparing

Normal professional training is to make absolute measurements. So if trends or changes are to be identified, or conditions compared between households or between places, this is through measurements made either at different times, or of different things, or in different places. Our preoccupation with numbers drives us to ask: “how much?” For sensitive subjects such as income, such questions can sow suspicion, wreck rapport, and generate misleading data (Chambers 1994).

3.5 From Reserve to Rapport

These reversals of frame and mode follow from, generate and reinforce a reversal of relations, from suspicion and reserve to confidence and rapport. With outsider-insider interactions, there is a scale of formality-informality, from the structured interview with questionnaire, through the semi-structured interview with checklist of subtopics to the conversations; outsiders ask questions (Chambers 1994).

3.6 From Extracting to Empowering

Reversals of frames, modes and relations contribute to reversals of power. In the forms which have spread, PRA has stressed abdication of power and passing much of the initiative and control to local people.

In classical social anthropological investigation, too, the ultimate aim has been to obtain data which are then analyzed and written up away from the field. Participant observation demands and creates sharply different relationships to questionnaire surveys but the basic objective remains similar (Chambers 1994).

4. Preliminary Analysis

This section attempts to address and show a preliminary analysis of the needs to incorporate PRA so that dissemination process of EWS may work well. PRA has strong capabilities to link local knowledge and include it to achieve a plan and action. This has been proven by several research studies in many other fields. But how good are the contributions of PRA in EWS dissemination process? Here, the six characteristics of PRA in previous section are used for frame of discussions.

The first shift *from etic to emic* allows the method to involve the thoughts of an insider rather than an outsider, notably researcher is consider as an outsider because he originally does not belong to the community. This shift is relevant with the aims of early warning systems. EWS as discussed earlier are aimed to provide information to the communities and to make it familiar for them. Thus, EWS need to have high involvements of users, including the communities. With methods of PRA, the communities can learn how to define the EWS themselves. This can be started for example by defining what kinds of hazards that they really encounter. Subsequently it follows with how and when to evacuate. The characteristics of PRA means that EWS are hoped to be developed by involving local people's thought. This argument addresses the issue of awareness that is discussed earlier in the literature review.

The second shift *from individual to group* encourages the sense of belonging to the activities, including to the early warning systems. Working in group allows a shared knowledge and a process of knowledge sharing. In this sense, everyone takes part in learning.

In the context of EWS, the shift *from verbal to visual* plays an important role. In rural areas, many people do not understand technical terms or event illiterates. Visual approach bridges the gaps of information that is going to be revealed. In the case of EWS for example, the EWS can be depicted in the context of local and familiar figures.

The shift *from measuring to comparing* helps to get information of how a community can assess it's internal characteristics, i.e.: vulnerability, disaster, etc. Therefore this can help the efforts to build EWS including to define who are endangered by hazards, develop scenarios of hazards, to identify who are the most vulnerable, etc.

The shift *from reserve to rapport* is to change the ambiance so that the local community does not feel enforced in doing the activities. The experience with PRA is that when outsiders being unhurried, showing respect, explaining who they are, answering questions, being honest, and being interested: and asking to be taught, being taught, and learning. With rapport, it is expected that PRA can build a smooth bridge between government and researchers (outsiders) with the local community (insiders). It is expected that this will help to understand what the community feels.

The shift *from extracting to empowering* is obviously increases the bargaining position of the community. As a result their voices and knowledge in the context of disaster preparedness are taken into account. This condition will bring improved quality of implementation of EWS.

The discussions of six PRA characteristics above describe the contribution of PRA in dissemination process of EWS. In addition, PRA have proven to be useful to incorporate local people in many cases as have been discussed in the previous section. Given its

capabilities, PRA could be of use in the managing EWS. EWS, as discussed in section two, needs to be understandable and to be accustomed with the community characteristics. PRA can be of help in this matter because PRA allows community to contribute in managing the EWS. The strength of PRA is that they permit scientists to understand important local perspective issues, including visualizations of the hazards (Cronin et al 2004).

5. Conclusions

The characteristics of PRA discussed above may well fit the needs to increase the quality of dissemination process of EWS. With those characteristics, PRA is considered as a potentially effective method to support the implementation process of Early Warning Systems, given some limited conditions and socio-cultural contexts. . With that reservation made, the use of PRA will quite likely allow all participants in the community to have their voices to be taken into account. As a consequence, this may lead to a better implementation of Early Warning Systems.

Some Issues related with EWS and communities have been discussed in the literature review. As discussed in section 2.1, there several of concerns including: familiarity with EWS, local knowledge, education, failure of response, low cost technology and local participation and collaboration between local community and researchers.

In conclusion, this paper has argued that PRA may take a significant role in order to address those issues as discussed in section 4. PRA appears to explore the possibility to increase local community's involvement in such cases as well as to tackle the problems. Since this paper has shown only a preliminary analysis to start with, further detailed and more specific studies are needed. With regard to the six characteristics of PRA, we need to examine how those problems would arise in the context of EWS. Case study areas are also needed to achieve such an extended research purpose.

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津波災害を受けやすい地域コミュニティのための早期警戒システム: 参加型アプローチ(PRA)の必要性に関する予備的分析

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要　旨

本研究は津波災害を受けやすい地域コミュニティのための早期警戒システム(EWS)を活用するために参加型アプローチが必要であることを説明する。地域コミュニティにEWSを導入する上でのいくつかの研究的課題について言及する。PRAの手法が参加型アプローチに有用であり、それが6つの特性を充足することを説明し、その適用のためのフレームワークについて予備的分析をする。さらにそれをEWSに適用する必要性と適用可能性について議論する。最後に今後の本格的な研究につないでいくための課題について触れる。

キーワード: コミュニティ, 津波, 早期警報システム, 参加型アプローチ, PRA