Community Resilience Assessment to Natural Disasters by Using Indicator Based Approach - Case Study in Ayeyarwaddy Region

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***Abstract*:** *One of the most important goals of assessing coastal community resilience, in particular, is to generate a readily understandable link between the theoretical concepts of community resilience and the day-to-day decision-making process and to encapsulate this link in an easily accessible tool. This paper is an attempt to develop a conceptual and methodological framework for the analysis, measurement, and mapping of coastal community resilience of the targeted areas using a Coastal Community Resilience Index. Firstly, it examined the general definitional issues of the concept of resilience with a focus on coastal community disaster resilience. Secondly, it reviewed the frameworks that are used to measure community resilience. The index is developed based on five resilience-based dimensions: social, physical, institutional, coastal zone management and natural. In the present study, 'community resilience index' of 26 Townships in Ayeyarwaddy Region was assessed through a systematic questionnaire survey. Thirdly, resilience information is presented as overall resilience, and separate social, physical, institutional, coastal zone management and natural and environmental resilience. Finally, it summarized the recommendations of integrated planning for natural disaster resilience to reduce the vulnerability of Coastal community. As a result of study, eight townships are classified as low resilient township and two are high and the rest were found to be in moderate resilience categories. In general, it can be concluded that community resilience directly depends on the level of understanding and knowledge about disaster risk reduction, i.e., the more knowledge about disaster the community have, the more resilience they have to backbone from disaster.*

Key Words: *Community, Ayeyarwaddy, Disasters, Resilience Index, Vulnerability.*

1. INTRODUCTION:

Natural disasters are caused by hydro-meteorological, climatological, geophysical and biological phenomena which adversely impact on the natural and built environment of affected regions. These disasters are increasing in frequency and magnitude—measured in terms of human lives lost, destroyed infrastructure, ecological damage and disrupted social networks. These physical threats are expected to be more common in areas such as low-lying and low-sloped areas. Therefore, coastal communities around the world are also increasingly at risk from cyclones and many other coastal hazards including floods, tsunamis, severe storms and shoreline erosion. Coastal floods are regarded as among the most dangerous and harmful of natural disasters. Myanmar encounters various types of storms that impact coastal communities, such as severe thunderstorms and tropical cyclones. In consequence, several serious floods have occurred, especially, due to storm surge. They destroyed the property, assets, social service, economic activities and natural environment. There have been numerous assessments and management plans to identify these particular areas with higher susceptibility to coastal hazards, however, the number of disasters and scale of impacts are increasing and causing even larger damage. So, it is important to plan and execute pre-disaster developmental activities in order to minimize the impact of possible disasters. The paper aims to gain and analyse the information relevant to disaster and climate resilience of the delta communities living in Ayeyarwaddy region.

2. CONCEPT OF RESILIENCE:

The concept of resilience has been developed and explored in fields as varied as psychology, materials science, economics and environmental studies. The application of the resilience concept to natural hazards was initially the focal argument in the assessment of natural hazards, which suggested that resilience was the ability of a community to recover by means of its own resources .In general, resilience is defined as the ability of a social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event. Likewise, 'community resilience' in coastal areas can be defined as the capacity of a linked 'socio-ecological system' to absorb recurrent disturbances without significant functional deformation .Over the past few years, several researchers have attempted to formulate quantitative as well as qualitative indicators with particular relevance to community resilience against natural disasters. It is essential to reduce the complexity of the measuring progress, allows a comparative analysis among the adjacent places and further serves as an important tool for the decision makers. Even though, coastal urban areas differ significantly from coastal rural areas as community dependence on coastal ecosystem services. Rural dependency on coastal resources, particularly in economically depressed coastal areas across the developing world, often makes 'human- environment'

relation unsustainable. Therefore, a new set of appropriate indicators are required to assess resilience of the resource dependent rural communities in the low lying coastal areas beside the traditional indicators used in the earlier frameworks.

3. CHARACTERISTIC OF STUDY AREA:

Ayeyarwady Region is a region of Myanmar, occupying the delta region of the Ayeyarwady River. The region lies between north latitude 15° 40'and 18° 30' approximately and between east longitude 94° 15' and 96° 15'. It has an area of 13,566 square miles (35,140 km^2). According to the National Census 2014 of Myanmar, there are 6175123 populations in Ayeyarwady Region. It is a low-lying coastal area and an alluvial area. It have about 460 km long coastline (from the Mawtin Point to the Gulf of Moattama). For the delta, the climate is classified as a tropical monsoon climate. The average annual rainfall in the delta is 1,500-2,000 mm. There are often strong winds from the south and southwest, causing rough seas. Cyclones can cause serious storm surges. Rivering flood and river bank erosion is one of the major issues in the Ayeyarwady Delta. River bank erosion takes mainly place in the Upper Delta, where the river geomorphology is still very dynamic. Bank erosion causes sedimentation in the river beds building up local barriers which can provoke localized flooding danger. Flooding has always been one of the major hazards in Myanmar. The threat of flooding usually occurs between June and October with the highest risk in August around the peak monsoon rains. The largest tidal range along the Ayeyarwady coastline can enhance the occurrence of flood events. Especially the upper parts of the delta are flooded more often since the highest discharges occur there and rivering flood are occurred due to combination with the earlier mentioned tidal influence in lower part of delta. The coastal region of Myanmar is prone to cyclones and accompanying storm surges. It directly showed the extreme vulnerability, in particular of the country's coastal regions and delta areas, to such low frequency high-impact natural hazards. Location map of townships in Ayeyarwaddy region is shown in Fig 1.

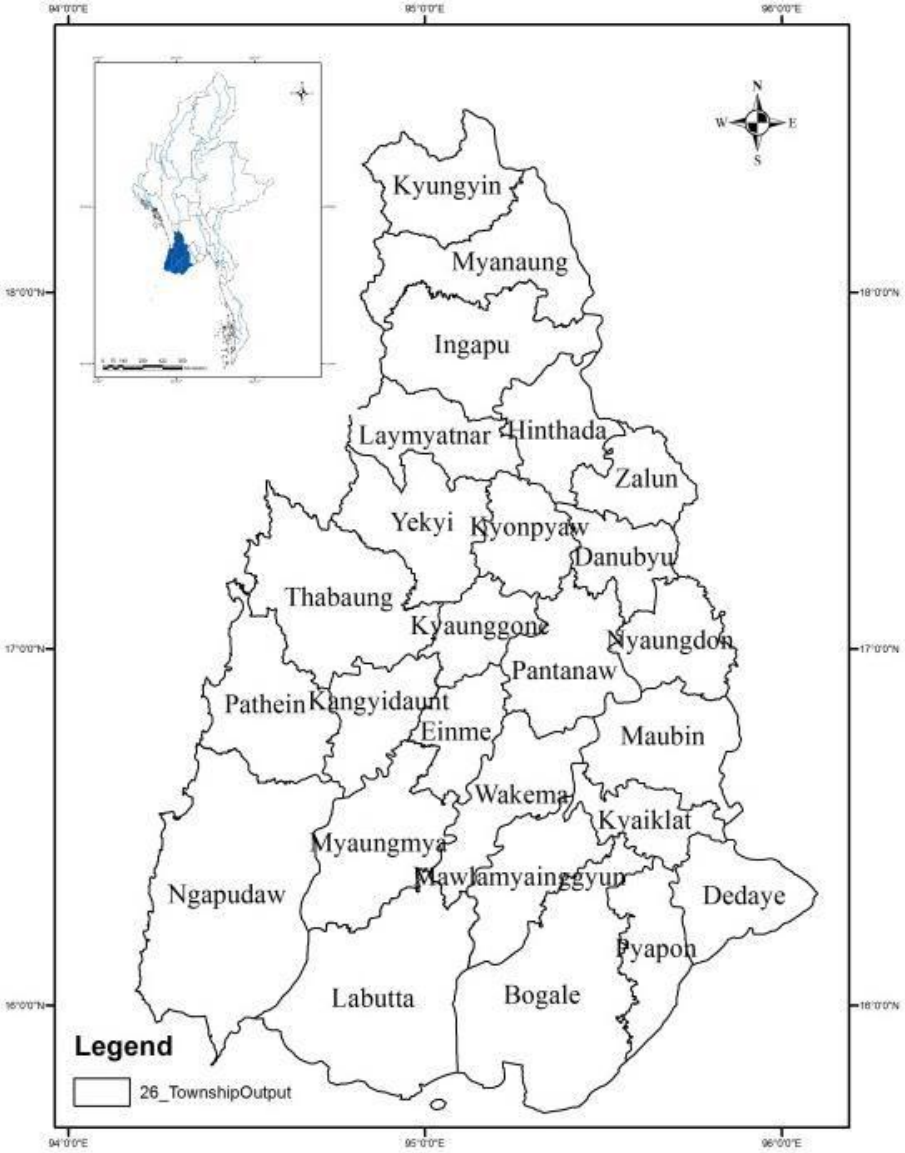

Fig. 1 Township boundary map in Ayeyarwaddy Region

4. METHODOLOGY:

Methodology of this study is divided into three parts. Firstly, it reviewed the frameworks that are used to measure community resilience. Then, 'community resilience index' of 26 Townships of Ayeyarwaddy Region was assessed through a questionnaire survey. Secondly, data storage, processing and analysis are presented. Finally, action plan workshops are made to summarize the recommendation of integrated planning for disaster & climate resilience to reduce the vulnerability of Coastal community in Ayeyarwaddy Region.

Data Collection and Processing

Advance Coastal Community Resilience Index (CCRI) is produced and this framework comprises a 5 × 5 harmonized approach. The final list of major dimensions, indicators and variables were developed after an iterative discussion with the local stakeholders such as local government officials and community groups. The framework considered five key dimensions of coastal resilience i.e., socio-economic, physical, institutional, coastal zone management, and environmental/natural resilience. Each dimension corresponds to five indicators and each indicators comprises five variables .Variable used in coastal community resilience are presented in Table 1. Addressing all parameters and variables of the dimensions, a data template was designed for data collection from each coastal community (in each township). Questionnaire survey was the prime means of data collection. Secondary data was also collected to supplement collected data. Field survey is conducted to twenty six townships of Ayeyarwaddy Region to obtain the detailed data through CCRI questionnaires from January 2016 to April 2016.

Table 1. List of variables considered in CCRI five dimensions

Dimensions	Variable considered
Socio-Economic	Demography, Health, Livelihood, Community Governance & Social Capital, Education & Awareness
Physical	Transportation, Residential Infrastructure, Electricity, Tele-communication, Water and Sanitation
Institutional	Laws & Policies, Coordination, Emergency Response, Adaptive Actions, Governance related to natural disaster
Coastal Zone Management	Embankment and Shoreline Protection, Mangrove Management, Coastal Bio-diversity Conservation, Coastal Pollution, Coastal Land use
Environmental and natural	Frequency of Natural Disasters, Climatic Components, Geo- physical Components, Bio- geochemical Components, Environmental Safeguard Actions

Data Analysis

The collected data were analysed and some weights were assigned to estimate Coastal Community Resilience Index (CCRI) by using aggregate weighted mean method in Microsoft Excel. Therefore, the framework introduced a weightage scale ranging from 1 to 5. The respondents were asked to prioritize the impact of a particular component by weighing between 1 (not important) and 5 (very significant). Aggregate Weighted Mean Index or AWMI (for each dimension) was calculated by using Weighted Mean Index (WMI) method. Initially, rating scale has been constructed and weight has been assigned subjectively based on how the community officials perceive the vulnerability of each variable by comparing them one by one. Each dimension corresponds to all variables through which their respective scores are calculated. For example, under socio-economic dimension of CCRI, there are five variables including demography, livelihood, health, social capital, and education and awareness. These variables were chosen to clearly describe the resilience in above five dimensions. Rating scales are given the numbers 1, 2, 3, 4, 5 corresponding to very low, low, moderate, high and very high respectively. Therefore, WMI was calculated by summing the product of the weights (given by township officials) to the index of each variable (obtained from the sum of rating scales under any given variable divided by the number of elements) and finally dividing the whole by the number of variables in each dimension. Overall CCRI values are obtained after averaging each of the five dimensions' resilience values.

5. RESULTS:

Composite Resilience of Townships in Ayeyarwaddy Region

In the present study, community resilience of all townships of Ayeyarwaddy Region was assessed through a questionnaire survey and the composite resilience scores were found to vary between 2.71 and 3.77 in a five point scale. Based on analysis, community resilience level is directly proportional to awareness level about disaster. Some community has been affected by previous disaster but their experiences have not been systematically shared with new generation. The understanding level of knowledge and awareness about the risk and impact of disaster on students in the townships affected by Nargis is good, but students in other townships are very less aware about Disaster Risk Reduction (DRR). Student should be trained for disaster preparedness at school and students must share to their

parents and relations at home in collaboration with Relief and Resettlement Department (RRD) and Department of Education. Knowledge about DRR should be shared in all village tracts and villages in townships by using pan flats, posters and boards from Department of Information and Public Communication, RRD and township general administrative department.

Resilience Analysis for Socio-Economic Profile

Overall socio-economic can be generally defined as low to very high. Out of four in twenty-six townships, education and disaster awareness resilience seems to be poor. . The reason why is depending on low understanding level of local community to vulnerability and threads of disaster. Some activities for education and awareness program only existing activity and less of implementation or action plans. Another main issue is that the dropout rate between primary level and middle school level is very high because children are working at different kinds of job as child labour with very low payment because of their families' social economic problems. Social cohesion among local people is very strong and some of the elder who know well about their community can participate in decision making process in some township such as Myaungmya Township. Besides, the acceptance of local leaders amongst community members in villages is good because they are selected through voting system. Hence, community governance and social capital resilience is marvellous in twenty-one townships. Socio-Economic resilience map is shown in Fig 2 (a).

Resilience Analysis for Physical Profile

Physical resilience varies from moderate to very low. This is due to poor transportation system, high vulnerability of housing to disaster, lack of safe drinking water, lack of hygienic toilets and low reliability and robustness of electricity. In electricity sector, there is rural electrification plan to provide electricity to villagers who live two miles away from national grid in the first phase and those who live five miles away in second phase in the coming fiscal year. Thus, those sectors have developed over the past few years. While coastal townships such as Labutta, Bogale, Pyapon, Dedaye use to face intrusion of saline water, heavy metals (arsenic, lime) contaminate into tube wells in inland townships (Kyaunggone, Hinthada, Kyonpyaw). Physical resilience map is shown in Fig 2 (b).

Resilience Analysis for Institutional Profile

In general, institutional resilience can be categorized between high and low as shown in Fig. 2 (c). The integration of disaster risk reduction in regular developmental activities is implemented in some components. The emergency response in disaster in all townships is good because they can manage as fast as possible and good supporting from regional level. Some townships (for example; Labutta, Bogale) have very good emergency response skills and knowledge gained through their experience of 2008 Cyclone Nargis time. The public awareness for environmental conservation activities are little weak. Some law and policy such as environmental conservation, forest law, freshwater law, pesticide law, and agriculture law and land use policy/law are not properly followed by communities. Some of the Environmental laws are needed to be upgraded and community's understanding for environmental conservation needs to be enhanced.

Resilience Analysis for Coastal Zone Management Profile

Embankment protection seems to be main challenge because almost all of twenty-six townships are located near waterway (creek, stream, river or sea) and their banks are protected by old earthen dike or embankment. Those embankments cannot sufficiently protect from flooding and bank erosion. Some townships such Bogale, Labutta have plans for ecosystem management, technological intervention to control salinity, mangrove management but they need more institutional arrangement because some part is only still implementation process. Although some forest area are used to development in agriculture, there is no many alternative in coastal land use in past 20 years. It is very less frequency of monitoring coastal water quality and remediation measures. As experience and knowledge of 2008 Cyclone Nargis, plantation of mangrove have improved in extreme coastal areas, for instance, Pyapon, Labutta , and Bogale townships. Almost all of townships cannot measure coastal/river pollution and it needs to control wastewater from sewer systems directly discharged into rivers and streams without any treatment. Coastal zone resilience profile is shown in Fig 2 (d).

Resilience Analysis for Environmental and Natural Profile

Environmental and natural resilience is lower than resilience of other sector in all townships. The frequency of some natural disasters occurs every year. The main hazards are flooding and river erosion in rainy season. Ngapudaw and Mawlamyainggyun townships have the lowest environmental/natural resilience because there is no technology and equipment to measure heavy metal contamination, high soil salinity and level of geo-morphological vulnerability. Now, measurement and monitoring of environmental conservation such as the impact of the sea level rise and reduction of fresh water flow, increase of water salinity in inland waters, level of geo-morphological vulnerability, and

losses of shoreline are planned to implement but some are not implemented because of limited budget. Environmental and natural resilience map is shown in Fig. 2 (e).

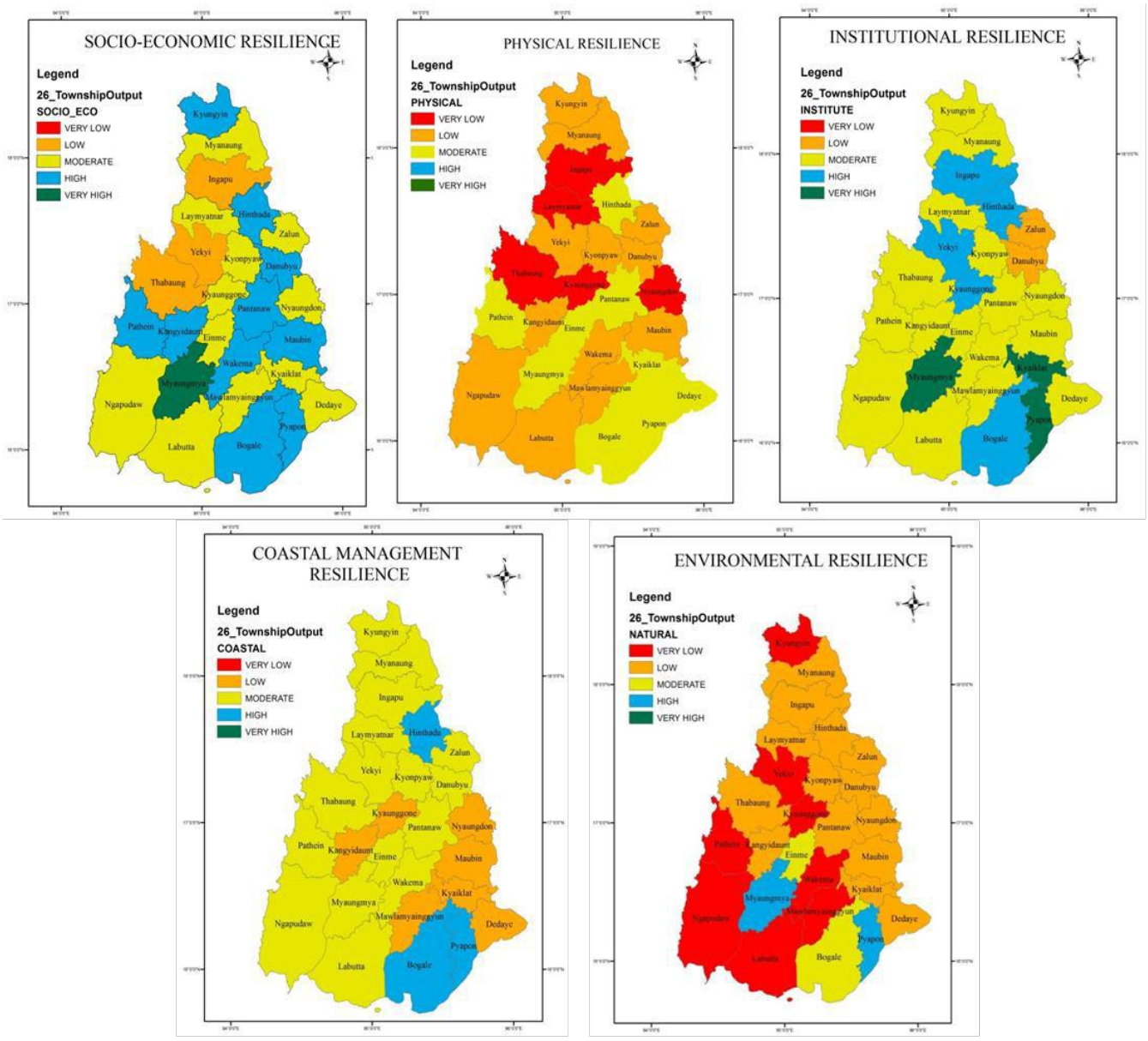

Fig. 2(a) Socio-Economic Resilience Map; (b) Physical Resilience Profile Map;
(c) Intuitional Resilience Profile Map; (d) Coastal Zone Management Resilience Map;
(e) Environmental and Natural Resilience Map

6. RESULTS AND DICUSSIONS :

The overall resilience level of all townships in Ayeyarwaddy region are described in Table 2. Out of Twenty-six townships, only two townships (Myaungmya and Pyapon) can be found as the high resilient areas where as eight townships are found in low resilience conditions and the rests are classified to be moderately resilient. It can be suggested that composite resilience score is significantly influenced by mainly three factors, i.e. socio-economic resilience, Coastal Zone Management resilience and Environmental and Natural resilience. Availability of sufficient evacuation centers (schools, monastery, and some religious buildings) as per the township population is not enough because they have no proper evacuation center. Some Townships (Zalun, Naundone and Danubyu) are situated along Ayeyawaddy River, they it is very vulnerable area of flood and high erosion because of its topography. Another one main disaster is river bank erosion and some villages transfer to inland especially Kye Htone and Out Htone village in Maubin. The existing embankment are old earthen dike and it is important to be heighten and maintenance of these dike. Nore technical and materials is needed to prevent erosion near bank of river for foster resilience. To enhance the resilience in environmental issues and reduce the pressures on coastal trees and forest, assessment of coastal

biodiversity should be conducted. In order to protect and conserve the depleting mangrove resources in time, the Integrated Resource Management Approach should be implemented.

7. CONCLUSION:

This paper provides a first-attempt in developing replicable and robust indicators for measuring and monitoring the coastal community disaster resilience of places. Because the science of resilience is still in its infancy, incremental empirical developments such as these are necessary to advance our understanding of the multidimensional nature of resilience and its constituent parts. CCRI is a powerful tool for mapping of vulnerable areas within the Ayeyarwaddy region. Thus, the correct use of CCRI can help policymakers and urban planners in making decisions with regard to development in specific areas and possible funding allocation for adaptation and reduction of disaster vulnerability in coastal areas. Thus, the CCRI is necessary, but not sufficient for decision-making. The CCRI has to be used in combination with other decision-making tools, which include participatory methods with the population of areas identified as vulnerable and expert judgment. More importantly, it would provide hazard managers with a tool that is similar to resilience in its relationship to vulnerability but offers greater potential in application, especially when attempting to move away from disaster recovery to disaster prevention and preparedness.

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