EVALUATING COASTAL FLOOD RISK ADAPTATION IN THE CONTEXT OF CLIMATE CHANGE

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ABSTRACT

Increased population and urban growth have made converting open spaces (non- climate factors) that can cause flooding as well as Surabaya has delta system of coastal morphology, high rainfall (climate factors) and it also has a characteristic of low land. In addition, adaptation that government done is not appropriate, because applied adaptation is mostly based on sudden-onset hazards. There are serious limitations in existing evaluations of climate change adaptation. So, this research tries to evaluate flood risk adaptation in Surabaya to get better understanding in term of successful adaptation measure.

Mixed qualitative and quantitative method is used in this study. Sixteen sub-criteria were identified in literature review and had been cross checked with stakeholders. Multi- criteria analysis (MCA) was used to measure the success of adaptation strategies after finding evaluation criteria by using Delphi Analysis. The data input for evaluation is from literature reviews and interview results of eight stakeholders that chosen by using purposive sampling. The selected adaptation measures that will be evaluated are mangrove conservation area, elevating house floor, and enhancing soft skill of local people.

Based on analysis result, the percentage of success for Conservation mangrove, elevating floor, and Enhancing soft skill are 57.57%, 61.61%, and 57.14% respectively. The result shows that there is no maladaptation in Surabaya coastal area because the evaluation value is close to the target. Moreover, local people have enough awareness to face flooding. They no longer feel the flood as one of the threats, but they considered it as a matter limitation that they face every day.

Keywords: adaptation measure, climate change adaptation, evaluation, flood risk adaptation, successful adaptation

INTRIDUCTION

Urbanization or urban growth shows to the concentration of the human populations into separated areas. It can cause land use changes for commercial, industrial, transportation and residential purposes.Surabaya city is the center of East Java and one of the coastal city in Indonesia which has delta system of coastal morphology and it also has a characteristic of low land so that area has vulnerability to flood (Pamungkas, 2006). Topography of Surabaya is a low land with the height about 1-6 meter below sea level (Masterplan of Surabaya, 2013). That

condition makes coastal area in Surabaya has flood potential.

Beside that, According to IPCC (Intergovermental Panel on Climate Change) report, the average of global climate has risen about 0,3-0,6 ˚C since the last of 19 century until 2100 and earth temperature is predicted to increase about 1,4-5,8˚C (IPCC, 2007). That phenomenon in increasing temperature of the earth has effected in climate change and sea level rise. IPCC had predicted that sea level rise is increasing about 15-90 cm with certainty increases as high as 48 cm during 100 years from 2000. The increasing sea level will soak some islands and low lands.

The rising of global temperatures effect to climate change and sea level rise. The effect of global warming has resulted in high intensity rainfall that is resulting in an increasing frequency and intensity of floods. The frequency and intensity of flooding are predicted to occur 9 times greater in the next decade in which the 80% increasing in the flooding occurred in South and Southeast Asia (include Indonesia) with extensive floodwaters reached 2 million square miles (IPCC).

Flood‘s effect will damage some aspects with the heavy destruction in aspects following:population aspect (victim who died), injured, float off, lost, and got disease, etc), economicaspect (loss of livelihood, traditional market malfunction, damage and loss of property,livestock and disruption of the community's economy), infrastructure aspect (damage ofhouses, bridges, roads, office buildings, public facilities, the installation of electricity,water and communications networks), environmental aspect (damage of ecosystem,tourism, land farming, water, and irrigation) (Departement of Disaster Management, 2007).

There are conflicts between risk management, climate change adaptation and urbandevelopment in coastal area of Surabaya. That can be shown from big number of floodvictims in that area (Immadudina, 2013). Adaptation that government done is notappropriate, this is because adaptation applied in there is only based on sudden-onsethazards, not long term strategies.

Then, like Greivingvet.al (2006) mentions that one studies the role of spatial planning in natural hazard risk management in several European countries found some very interesting conclusions are summed role of spatial planning in the management of major hazards such poor used to, such as limiting development in hazard-prone areas. Later than that, in many cases, the multi-hazard approached there because there are so many organizations that deal with different types of hazards to work independently. They found a lack of coordinated activities between the stakeholders involved as well.

METHODOLOGY

This research uses Quantitative and Quantitative Methods. Quantitative includes scoring for for weighting criteria. Besides, Qualitative Methods is used to exploring criteria given by stakelokders using Delphi Analysis. Figure 1 shows the methodology of study in three tasksconducted for evaluating adaptation measures in which primary and secondary data will be use to support In that figure explains about every task that have to through to get the successful adaptation measures.

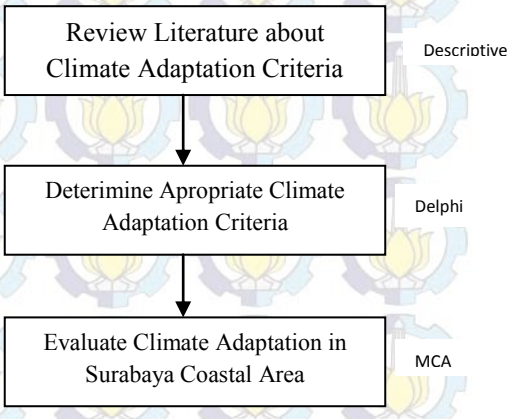

Figure 1 Methodological Framework

RESULTS

Criteria for Evaluation

Criteria from literature review need to be crosschecked to stakeholders to get the appropriate criteria for evaluation. Before distributed to stakeholders, the criteria has been explored to get sub-criteria by descriptive analysis from literature review. Then, the stakeholders would check the cub-criteria to get evaluation sub-criteria. Each criterion and its explanation can be seen at **appendix 1**.

Then, to determine evaluation criteria, Delphi Analysis has been done. There was three phases to get the exact criteria to evaluate adaptation measure. Based on the analysis Delphi to get consensus on the cub-criteria to evaluating of adaptation measures, then the exact sub-criteria following:

i. Enhancing policy, planning for adaptation measure
ii. Legal and regulatory
iii. Integration with development policies and planning
iv. Institutional mechanism, capacities and structures
v. Hazards risk
vi. Scientific and technical capacities and innovation
vii. Impact data
viii. Environmental and natural resources
ix. Livelihood
x. Culture, attitudes, education
xi. Financial instruments
xii. Cost recovery for adaptation
xiii. Maintenance and Operation Cost
xiv. Public awareness, knowledge, skill
xv. Information management and sharing
xvi. Learning and research

Evaluate Performance of Flood Risk Adaptation in The Context of Climate Change

The selected adaptations measures that will be evaluated are mangrove conservation area, elevate floor house, and enhance soft skill of community. To evaluate this adaptation measure, it has been used criteria from earlier section (section A) which has been crosschecked by stakeholders.

The process of assessing the success of adaptation in this study was done by a multi-criteria using AHP method. In using AHP, the decomposition needs to be done to identify problems with the criteria and sub-criteria used.Table of criteria and sub-criteria used to evaluate the success of adaptation strategies is showed at **appendix 2**.This multi-criteria analysis makes the analytic hierarchy process, with the main objective (goal) are in the top position, followed by the main criteria, sub-criteria, and alternatives issues. Hierarchy of research that has been compiled (Figure below) is the basis for the preparation of the questionnaire and data processing.

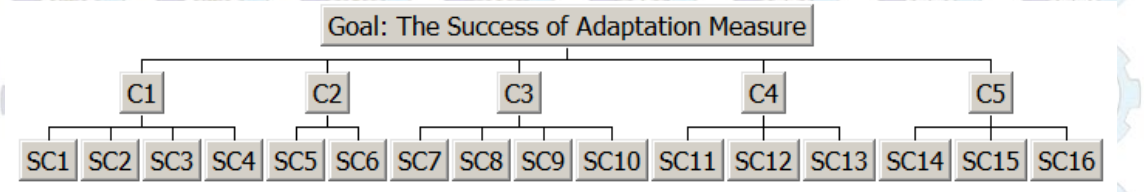

Figure 2 Hierarchies of Criteria and Sub Criteria on AHP Analysis

As for the result of a combination of all criteria and sub criteria weighting shows as Figure 3. This hierarchy at Figure 4 (see appendix 3 for AHP questionnaire) shows each criterion and sub-criterion with the weight. This weighting will be calculated with scoring to know the successful of criteria based on stakeholders's perception.

To get the score or value, scoring scale (see at **appendix 4** for value

questionnaire) is used to help in this multi-criteria analysis. In ranking method, every criterion consideration is ranked in order of the stakeholders' preference. To generate for each evaluation unit, each criterion was weighted according to the estimated significance for evaluating adaptation measure.

Basically, the evaluation of adaptation measures is to compare the performance indicators of the achievement of targets set by the researcher. In this section will be made a remedy worksheets provide an assessment and evaluation of the adaptation measure. But to give a score to each sub-criterion, the determination of value is done in accordance with the adaptation measures that will be evaluated. Each adaptation measure has a value and the class individually.

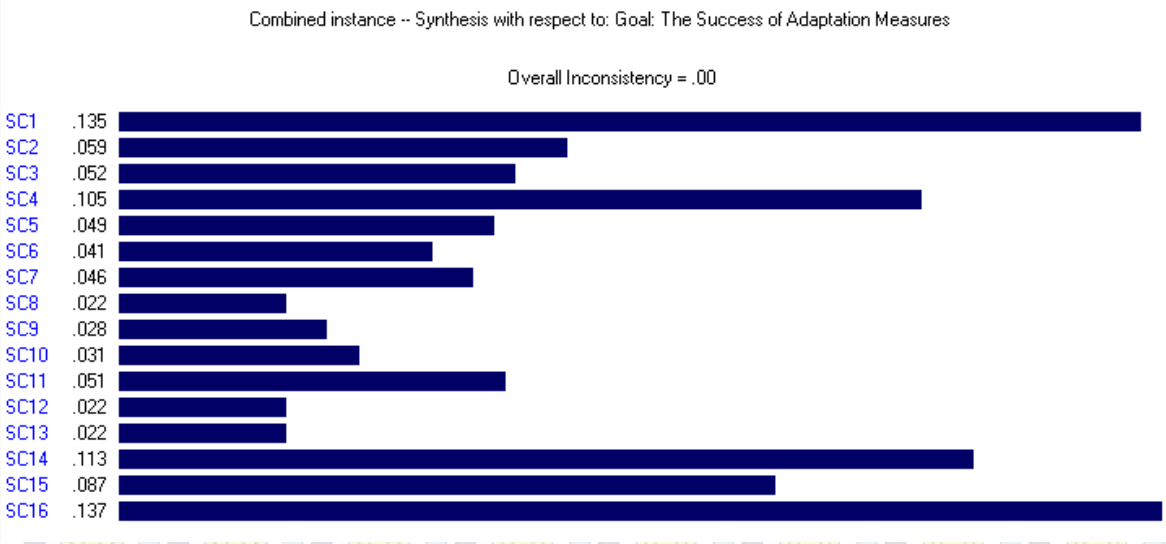

Figure 3 Weighting Sub-Criteria from Expert Choice Result

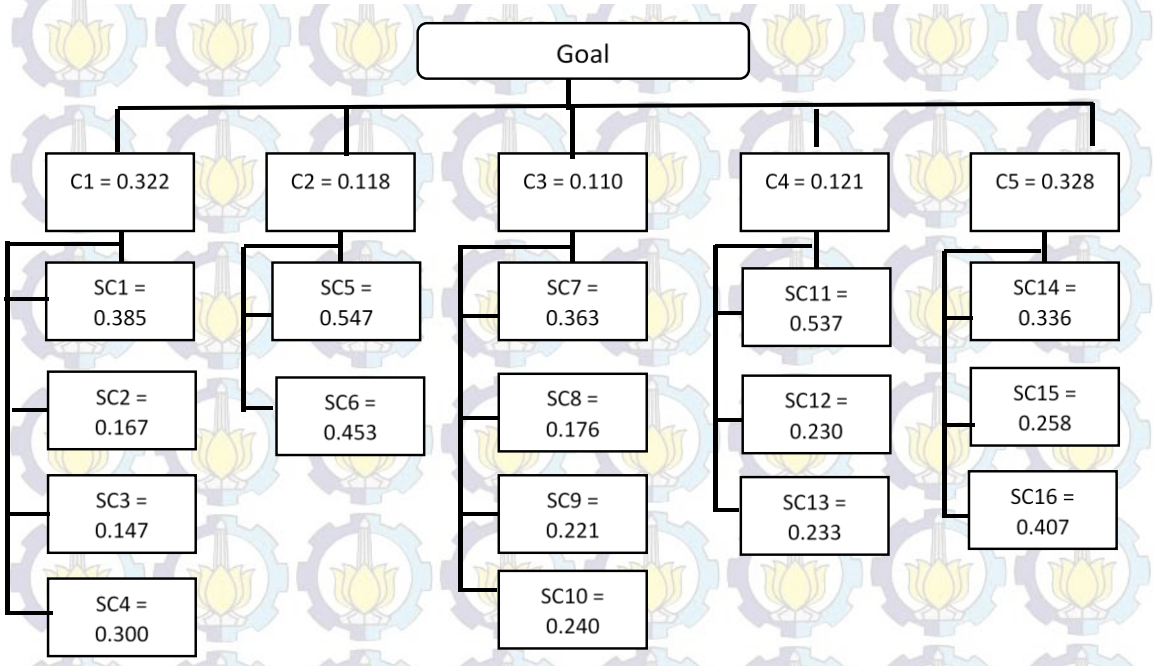

Figure 4 Combined Weighting of Criteria and Sub-Criteria

The total of questions is 16, according to the number of sub-criteria. In every response is given by value. With a purposive sampling, the sample size is eight people. Then the maximum value for the question is 16 x 8 = 128 and the minimum is 8 final score was obtained by summing the numbers for each answer.The amount or maximum rating for the 16 questions is 8 x 16 = 128 points and the minimum is 16 points. So scores ranged 16 - 128 of this amount will be multiplied by the weight and will obtainthe level of success of a program against goals and targets have been achieved.

Value will be used to calculate the percentage the success of adaptation measures. In the next sub-section, the value will be multiplied with weight to get the percentage.

According to calculation at Table 1 and Table 2, it can be known that the most successful adaptation measure is elevating floor. This adaptation is adopted by communities who live in coastal area. Criterion of Sustainability is the highest score in this adaptation, and then followed by flexibility which has score with 13.8%.

Then to assess the success, a standard traffic light system is used.

Table 1 Value and Weighting Sub-Criteria

No	Sub-Criteria	Value			Weighting
		Mangrove	Elevate Floor	Enhance Skill	
1.	Enhancing policy, planning	0.775	0.625	0.625	0.385
2.	Legal and regulatory	0.85	0.575	0.625	0.167
3.	Integration with development policies and planning	0.725	0.575	0.6	0.147
4.	Institutional mechanism, capacities and structures	0.45	0.575	0.375	0.300
5.	Hazards risk	0.575	0.725	0.5	0.547
6.	Scientific and technical capacities and innovation	0.55	0.65	0.475	0.453
7.	Impact data for flooding	0.575	0.525	0.575	0.363
8.	Environmental and natural resources	0.55	0.6	0.725	0.176
9.	Livelihood to people surrounding	0.6	0.625	0.675	0.221
10.	Culture, attitudes, education conditions	0.425	0.625	0.425	0.240
11.	Financial instruments	0.525	0.55	0.525	0.537
12.	Cost recovery for adaptation	0.525	0.5	0.5	0.230
13.	Maintenance and Operation Cost	0.45	0.55	0.65	0.233
14.	Public awareness, knowledge, skill to people surrounding	0.575	0.725	0.7	0.336
15.	Information management and sharing	0.575	0.6	0.725	0.258
16.	Learning and research related to enhancing adaptation measure	0.6	0.675	0.65	0.407

Table 2 Percentage of Selected Adaptation Measures

No	Criteria	Adaptation Measure		
		Mangrove Conservation (%)	Elevating Floor (%)	Enhancing Soft Skill (%)
1.	Effectiveness	13.63	11.87	10.91
2.	Flexibility	11.27	13.82	9.77
3.	Inequality	10.80	11.69	11.75
4.	Efficiency	10.15	10.77	10.97
5.	Sustainability	11.71	13.46	13.74
	Total	**57.58**	**61.61**	**57.14**

Traffic light system uses three colors: green with a threshold of more than 68% means that the achievement of the criteria already achieved, yellow color with a threshold of 52% to 68% means that the achievement of adaptation measure is not achieved yet though the value is close to the target, so the parties concerned should be fastidiously with a variety of opportunities and threats. The red color with a threshold of less than 52% which means that the achievement of an adaptation program actually below the target set and require immediate repair. The threshold is determined based on the characteristics of the overall criteria score.For this explanation, it can be concluded that three adaptation measure that choosen are in yellow color. It means all of adaptation measures have been achieved the targets but the score of this criterion is in yellow threshold.

DISCUSSSIONS

From the analysis results, it showthat there is no maladaptation in Surabayacoastal area because the evaluation value isclose to the target. Moreover, the current adaptation measures are not successful yet although the sustainability criterion including research has high percentage at average. Elevating floor is the mostsuccessful adaptation meaures in Surabayacoastal area.

There are many factors influencing its success. One of them is cost.For example local people use their ownmoney to elevate their floor to avoid flood. Because this adaptation measure is in thehousehold level so it is easy tomaintenance or apply. The evidence cans be seen at the precentage of flexibility criterion including cost as well asflexibility has the highest percentage for elevating floor. However, adaptation measures that happen at city level such as mangroveconservation area and enhancing soft skillof local people has different successful percentage. Mangrove conservation area has strength at effectiveness criterion including policy and planning because this adaptation measure has linked with the spatial plan implementation that involves controlling land use at mangrove conservation area. The role of governmentto enhance policy and planning is moreneeded.

Actually, enhancing soft skill oflocal people is not related directly to floodrisk adaptation measure. This adaptationmeasure tries to find other economicactivities, especially when floods riskcome so local people can survive andcontinue their life. This adaptation canreduce the socio vulnarability of people, that's why the sustainability criterion which includes public awareness, knowledge, and people skills have a high percentage.

CONCLUSIONS

To determine criteria of evaluation, literature review and Delphi Analysis have been conducted. Identification of criteria for the evaluation is done based on the study of literature and has been crosschecked with stakeholders to determine the existing condition in the evaluation. Criteria of effectiveness, efficiency, equity, flexibility and sustainability are said important in judging success. The sub-criteria that found in the literature is fifteen sub-criterion, but after conducted Delphi with three stages, agreement of stakeholders is found with one new sub-criterion. So, to evaluate performance of adptation measure, sixteen criteria has been identified.

Then, the analysis result identifies that there is no maladaptation in coastal area of Surabaya. The result shows the percentage of success for conservation mangrove, elevating floor, and enhancing soft skill are 57.57%, 61.61%, and 57.14% respectively. all adaptation measures that chosen are in yellow color. It means that the achievement of adaptation measure is not yet achieved yet although the value is close to the target.

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Appendix 1

Measure	Description	Sub-Criteria
Effectiveness: Achieving objectives	An effective adaptation intervention will achieve its stated objectives, be these to reduce vulnerability or risk, increase adaptive capacity, or achieve an enhanced level of protection. Evaluation against this criterion should therefore be relatively straightforward,providing that measurable objectives have been stated and clearly defined at the outset. Whilst effectiveness relates to adaptationoutcomes, it also relates to the adaptation process, including **capacity building, information exchange and social learning.**	• Enhancing policy, planning for adaptation measure • Legal and regulatory • Integration with development policies and planning • Institutional mechanism, capacities and structures
Flexibility: How far canwe adapt?	Climate change is uncertain, due partly to an incomplete **understanding of climate science**, and partly to the fact that climate changewill **impact upon a future world**. The large uncertainty around climate change means that it is likely we will either do too much, or toolittle, adaptation.	• Hazards risk • Scientific and technical capacities and innovation
Equity: Inequalitydimensions toadaptation	Adaptation aims to **reduce vulnerability** to climate change shocks and stresses. However, vulnerability also depends on **socioeconomicfactors**, which implies that any given adaptation may reduce vulnerability inconsistently across groups. Adaptation canreinforce existing inequalities, or it could be designed in such a way as to protect especially vulnerable groups	• Impact data • Environmental and natural resources • Livelihood • Culture, attitudes, education
Efficiency: Costeffectiveness	Efficiency or **cost-effectiveness** is typically used to compare the **costs of alternative ways** of producing the same or similar results, i.e.to assess the least-cost path to reaching a given target.	• Financial instruments • Cost recovery for adaptation
Sustainability: Thewider implications of adaptation	Sustainability of an adaptation is concerned with looking beyond the immediate sphere of the intervention's impact. It considers thelonger-term viability of the intervention (e.g. how far are the benefits of an activity likely to continue after donor funding has beenused up or withdrawn). It also considers the broader environmental, social and economic impacts of implementing an intervention. Sustainable adaptation is likely to include strong elements of **partnership-building, community engagement, education andawareness-raising**, as well as focusing on interventions which are 'mainstreamed' into existing development processes andmechanisms, and cutting across key sectors (water management, agriculture, health and education).	• Public awareness, knowledge, skill • Information management and sharing • Learning and research

Source: compilation of OECD (2007) and Rob D (2011)

Appendix 2

No	Main Criteria	Criterion Code	Sub-Criteria	Sub Criterion Code
1.	Effectiveness	C1	Enhancing policy, planning	SC1
			Legal and regulatory	SC2
			Integration with development policies and planning	SC3

No	Main Criteria	Criterion Code	Sub-Criteria	Sub Criterion Code
			Institutional mechanism, capacities and structures	SC4
2	Flexibility	C2	Hazards risk	SC5
			Scientific and technical capacities and innovation	SC6
3.	Inequality	C3	Impact data for flooding	SC7
			Environmental and natural resources	SC8
			Livelihood to people surrounding	SC9
			Culture, attitudes, education conditions	SC10
4.	Efficiency	C4	Financial instruments	SC11
			Cost recovery for adaptation	SC12
			Maintenance and Operation Cost	SC13
5.	sustainability	C5	Public awareness, knowledge, skill to people surrounding	SC14
			Information management and sharing	SC15
			Learning and research related to enhancing adaptation measure	SC16

Appendix 3

Score	Note
1	Sameimportant
2	Between1-3
3	Alittlebitimportant
4	Between3-5
5	Moreimportant

I.WeightingMainCriterion

Effectiveness	5	4	3	2	1	2	3	4	5	Flexibility
	5	4	3	2	1	2	3	4	5	Inequality
	5	4	3	2	1	2	3	4	5	Efficiency
	5	4	3	2	1	2	3	4	5	Sustainabilit

Flexibility	5	4	3	2	1	2	3	4	5	Effectiveness
	5	4	3	2	1	2	3	4	5	Inequality
	5	4	3	2	1	2	3	4	5	Efficiency
	5	4	3	2	1	2	3	4	5	Sustainabilit

Inequality	5	4	3	2	1	2	3	4	5	Effectiveness
	5	4	3	2	1	2	3	4	5	Flexibility
	5	4	3	2	1	2	3	4	5	Efficiency
	5	4	3	2	1	2	3	4	5	Sustainabilit

Efficiency	5	4	3	2	1	2	3	4	5	Effectiveness
	5	4	3	2	1	2	3	4	5	Flexibility
	5	4	3	2	1	2	3	4	5	Inequality
	5	4	3	2	1	2	3	4	5	Sustainabilit

Sustainabilit	5	4	3	2	1	2	3	4	5	Effectivenes
	5	4	3	2	1	2	3	4	5	Flexibility
	5	4	3	2	1	2	3	4	5	Inequality

y	5	4	3	2	1	2	3	4	5	Efficiency

II.WeightingSub-Criterion

Effectiveness

SC1	5	4	3	2	1	2	3	4	5	SC2
	5	4	3	2	1	2	3	4	5	SC3
	5	4	3	2	1	2	3	4	5	SC4

SC2	5	4	3	2	1	2	3	4	5	SC1
	5	4	3	2	1	2	3	4	5	SC2
	5	4	3	2	1	2	3	4	5	SC3

SC3	5	4	3	2	1	2	3	4	5	SC1
	5	4	3	2	1	2	3	4	5	SC2
	5	4	3	2	1	2	3	4	5	SC4

SC4	5	4	3	2	1	2	3	4	5	SC1
	5	4	3	2	1	2	3	4	5	SC2
	5	4	3	2	1	2	3	4	5	SC3

Flexibility

SC5	5	4	3	2	1	2	3	4	5	SC6

Inequality

SC7	5	4	3	2	1	2	3	4	5	SC8
	5	4	3	2	1	2	3	4	5	SC9
	5	4	3	2	1	2	3	4	5	SC10

SC8	5	4	3	2	1	2	3	4	5	SC7
	5	4	3	2	1	2	3	4	5	SC9
	5	4	3	2	1	2	3	4	5	SC10

SC9	5	4	3	2	1	2	3	4	5	SC7
	5	4	3	2	1	2	3	4	5	SC8
	5	4	3	2	1	2	3	4	5	SC10

SC10	5	4	3	2	1	2	3	4	5	SC7
	5	4	3	2	1	2	3	4	5	SC8
	5	4	3	2	1	2	3	4	5	SC9

Efficiency

SC11	5	4	3	2	1	2	3	4	5	SC12
	5	4	3	2	1	2	3	4	5	SC13

SC12	5	4	3	2	1	2	3	4	5	SC11
	5	4	3	2	1	2	3	4	5	SC13

SC13	5	4	3	2	1	2	3	4	5	SC11
	5	4	3	2	1	2	3	4	5	SC12

Sustainability

SC14	5	4	3	2	1	2	3	4	5	SC15
	5	4	3	2	1	2	3	4	5	SC16

SC15	5	4	3	2	1	2	3	4	5	SC14
	5	4	3	2	1	2	3	4	5	SC16

SC16	5	4	3	2	1	2	3	4	5	SC14

Appendix4

No	Criteria	Definitely disagree (1)	Mostly disagree (2)	Neutral (3)	Mostly agree (4)	Definitely agree(5)
1.	Effectiveness					
	Policy, planning,priorities and politicalcommitment are appropriate with existing adaptation measure					
	Legal and regulatory					
	Good Integration with development policies and					
	Good Integration with emergency response and					
	Good institutional mechanism, capacities and					
2.	Flexibility					
	Existing adaptationis relevantwith hazard/risk happeninarea					

No	Criteria	Definitely disagree (1)	Mostly disagree (2)	Neutral (3)	Mostly agree (4)	Definitely agree(5)
	Scientific and technical capacities and innovation areavailableto addressthe					
3.	Equity					
	Updated impact data is usedto makeadaptation measure					
	Environmental and natural resourcesareadvantageous					
4.	Efficiency					
	Financialinstruments do efficiency by government togetmaximumadaptation					
	Therearecostrecoveryfor					
	Monitoring and Operation Cost is appropriate to					
5.	Sustainability					
	Public awareness, knowledge, skill are					