Protocol for mapping climate-risks and associated adaptation plans

under Asian Mega-Deltas Initiative

INITIATIVE ON
Asian Mega-Deltas

INSTRUCTIONS FOR DEVELOPING CS-MAP

1. Overview of CSMAP

Participatory Mapping or mapping with professional knowledge, experience and actual knowledge of the community has been mentioned since 1970s (IFAD, 2009) and it appreciates local people's contribution in decision making. The Participatory Mapping is broadly applied not only in natural source management but also in many other fields (Chambers, 2006) such as developing of hunger elimination and poverty reduction, education, husbandry, and security maps, etc.

The Participatory Mapping method was also applied by Vietnam's Department of Crop Production and the CCAFS SEA in designing the approach for Climate-risk mapping and adaptation planning – CSMAP (Yên *et al.*, 2019). Maps were developed for climate risk scenarios in normal and extreme years, using available database on terrain, climate, hydrology, infrastructure and practical experience of farmers, scientists and local officers.

Local knowledge is very important in identifying affected area, the level of climate risks and adaptation measures taking into account local contexts (natural resources, infrastructure and production activities). In CSMAP, spatial and temporal factors are used in analysis following a 5-step process as specified in Figure 1.

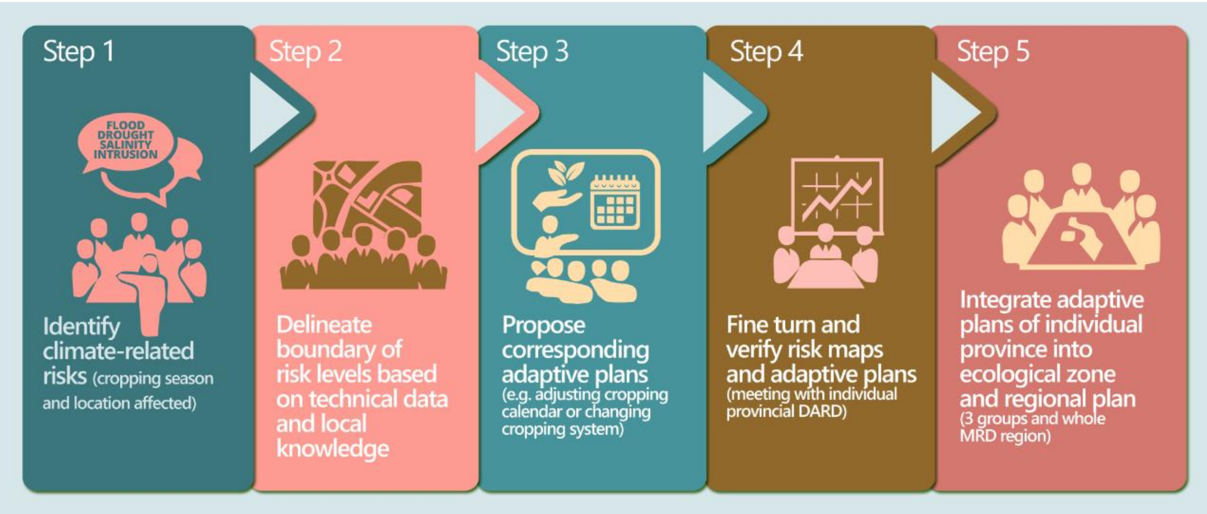


Figure 1. Steps of developing CSMAP

2. Steps in developing maps of climate-risks and adaptation plans

The process of developing CSMAP is perform collectively by agriculture, land use planning, hydrology, natural resources and environment officials, GIS experts, private sector partners and local people (i.e. agricultural extension officers, commune and/or village leaders, farmers, etc.) who have experience in agricultural production.

To develop maps for a province, detailed information needs to be updated from district level. Invite 2-3 representatives from each district (following criteria above) to participate in a provincial workshop/meeting.

Note:

- To take best advantage of indigenous knowledge, participation of a wide range of stakeholders from related agencies is recommended.
- The maps developed following steps below require frequent update by local stakeholders due to changes in biophysical conditions or agricultural development plans.

Step 1: Define Climate-risks

The extent to which Climate-risks affect crops depends on intensity and time of occurrence of the risks, and other factors such as crop variety and growth stage, crop management practices, infrastructure readiness, and local resilience capacity. For example, salinity intrusion causes less damage to crop at tillering stage than flowering stage. Therefore, climate-risks and their potential damage levels diverse among different areas within the same region under similar climate conditions. However, there are various understanding about the definition of climate-risks and their potential damage levels. Therefore, it is important to achieve common understanding among stakeholders through participatory mapping method.

Purpose: to develop criteria to determine Climate-risks.

Outputs:

- List of Climate-risks (i.e., drought, flood, …)

- Potential damage levels of those risks to crops (i.e., high, medium, low)

Methods/tools:

Refer to secondary data on Climate-risks, hydrometeorology, climate-responsive infrastructure and recent agricultural production in the targeted region.

Focus Group Discussion – FGD (Appendix 1): Organize thematic FGDs with 10-15 participants. This method encourages participants to share their opinions. During FGDs, the facilitator should respect all individual opinions, record the number of votes for and against each point. The ranking or scoring methods can be adopted to support decision making (Appendix 4).

Key Informant Panels – KIP (Appendix 2): KIP with scientists in the fields of agriculture, irrigation, hydrometeorology, land use planning, natural disaster prevention, and people who have experience in local agricultural production, community development, and local authorities. However, the quality of information from KIP is subject to the personal view and their expertise, and can be strongly influenced by their biases.

Materials and equipment required: A0 sheets, markers and colored papers.

Implementation process

S1.1. Prepare a list of Climate-risks

The facilitator lists Climate-risks in the targeted region and relevant causes (Appendix 3) on an A0 sheet (841 x 1189 mm) for all participants to view and discuss, and request participants to supplement the list if necessary (Table 1).

It should be noted that one type of risk to production can be caused by a variety of climate-related events, such as flooding can be caused by upstream flows or by local heavy rains. One

Climate-risk can also cause different subsequent risks. For example, drought can cause a shortage of necessary irrigation water and can induce salinity intrusion, which results in water becoming unusable for agricultural production. In case of multiple Climate-risks, the Pairwise Ranking Method (Appendix 4) can be used to select the Climate-risks to be prioritized.

Table 1: Example of Climate-risks and damage levels

Type of risk	**Year**	**Level**	**Damaged product**				**Reason**
			Rice	**Maize**	**Bean**	**Vegetables**	
Flooding	2000	Extreme	x	x	x	x	Severe flood from Mekong River
	2001	Moderate		x	x	x	Flood combined with heavy rain
Drought	2015	Extreme	x		x	x	Low river discharge, low rainfall
	2016	Moderate	x			x	Low river discharge, low rainfall
Salinity intrusion	2015	Extreme	x	x	x	x	Low river discharge, low rainfall
High temperature	2018	Moderate	x	x	x	x	Climate change

S1.2. Getting common understanding of potential damage levels

The facilitator asks participants to name the identified risks and how to evaluate their levels of potential damage in the targeted region. S/he takes notes on an A0 sheet for participants to view, discuss, and agree on the local names of the identified risks and criteria to evaluate their potential damage levels. It should be noted that potential of historical and future damages may be different due to the potential changes in infrastructure and other responsive measures.

Example: For the case of the Mekong River Delta (MRD) in Vietnam, the timing, frequency and intensity of the risk, and readiness capacity of a specific area are combined by participants to define 4 potential damage levels associated with proportion of potential yield loss: (1) High: more than 70%; (2) Moderate: 30%-70%; (3) Low: less than 30%; and (4) No affected: no significant effect on yield.

S1.3. Develop scenarios for Climate-risks

Potential damage levels of a Climate-risk are subject to timing, location and intensity of the risk, and land use type and readiness of preventive structures. Thus, it is needed to prepare different responsive scenarios. For instant, moderate vs severe drought events or regular vs intensive operations of irrigation systems…

To develop risk scenarios, the facilitator guide participants to list normal and extreme years of an identified climate disaster together with clear definition of the 'normal' and the 'extreme' events. Facilitators can use the same method being described in S1.1 and S1.2.

Step 2: Participatory mapping

S2.1. Study the base map

Purpose:

This step is for participants to get familiar with the base map, and check the place names and ground objects on the map. This step also allows updating the base map with recent changes.

Outputs:

Participants are able to recognize the directions, land marks and locations on the base map.

Methods/Tools:

The main method of this step is FGD (Appendix 1). In implementing the CSMAP method, through FGD, participants help each other get familiar with the maps.

Materials and equipment required:

The paper base map for hand-drawing, scale from 1:50,000 to 1:100,000 for province level, from 1:10,000 to 1:50,000 for the district level, from 1:5,000 to 1:10,000 for the commune level, and from 1:2,000 to 1:5,000 for the village level. The base map should include the following layers: topography, land use/land cover, land marks and administration. The base map should be printed in color on a A0 paper.

Implementation process

The facilitator asks participants to place the map following the correct direction and check the place names and ground objects on the map.

S2.2. Defining spatial and temporal boundaries of Climate-risks

A Climate-risk often occurs in a specific period of time. For example, floods caused by surplus flows and heavy rain often occur during the rainy season, while droughts occur during the dry season. Clear definition of temporal boundary will help participants to link the risk with the targeted agricultural product better.

Spatial boundary of the risk is often defined by physical land conditions such as terrain, relative elevation, soil type, and available of preventive structures (e.g. drainage canal, dyke, pump station, sluice gate, etc.) and development stage of the crop. Spatial boundary on the map can be determined by participants based on pre-prepared information of topography, administration, land use pattern and land marks of the target area.

Note: both temporal and spatial boundaries of a climate risk are relative and need to be defined for each scenario.

Purpose:

To define the temporal and spatial boundaries of the climate risk for each of agricultural products by pre-defined scenario (S1.3).

Outputs:

- A map for each Climate-risk in a scenario for a particular product by season.

- The potential damage levels of the risk in S1.1 are defined for every land management unit (such as plot, field or sub-region depending on the required details) on the map.

Methods/Tools

The main method to define the potential damage levels of Climate-risks is FGD (Appendix 1) which may be combined with modeling method.

The modeling method requires expertise in hydrometeorology and agricultural system. It is usually performed by research institutions because it requires a large number of input parameters and includes a complicated process of calibration and validation. Then, the simulation results will be validated by local stakeholders through FGD.

In implementing the CSMAP method, FGD enables sharing experience about the historical Climate-risks among stakeholders.

Materials and equipment:

- The paper base map for hand-drawing, scale from 1:50,000 to 1:100,000 for province level, from 1:10,000 to 1:50,000 for the district level, from 1:5,000 to 1:10,000 for the commune level, and from 1:2,000 to 1:5,000 for the village level. The base map should include the following layers: topography, land use/land cover, land marks and administration. The base map should be printed in color on a A0 paper.

- A transparent film of A0 size is placed on top of the map to allow participants to outline the spatial boundaries of the Climate-risk.

- It is advised to use erasable markers so that the film can be reused for multiple tasks. The markers should come in different colors for different types of information.

Implementation process:

S2.2.1. Delineate the temporal boundary of the Climate-risk

The facilitator guides participants to define the temporal boundary (a particular season or time period) and the relevant Climate-risks (outcome of S1.1). For example, floods usually occur in rainy seasons while droughts happen in dry seasons.

S2.2.2. Define risks, seasons, and scenarios for all agricultural products in the region

The determination of spatial boundaries of the climate risk on the map is carried out in various tasks for different products, planting seasons, scenarios and risks. Therefore, it is necessary to define clear tasks to carry of the delineation of spatial boundaries. The process is recorded in the Table 2 below:

Table 2: Define tasks for the participatory mapping process

Task	Season	Risk	Scenario	Remarks
Product 1				
1	Season 1	Risk 1	Scenario 1	
2	Season 1	Risk 1	Scenario 2	
3	Season 1	Risk 2	Scenario 1	
4	Season 1	Risk 2	Scenario 2	
5	Season 2	Risk 1	Scenario 1	
6	Season 2	Risk 1	Scenario 2	
Product 2				
…	…	…	…	

S2.2.3. Delineate spatial boundaries for Climate-risks

Note: The process from now until the end of Step 3 is carried out for each task (as defined in Table 2).

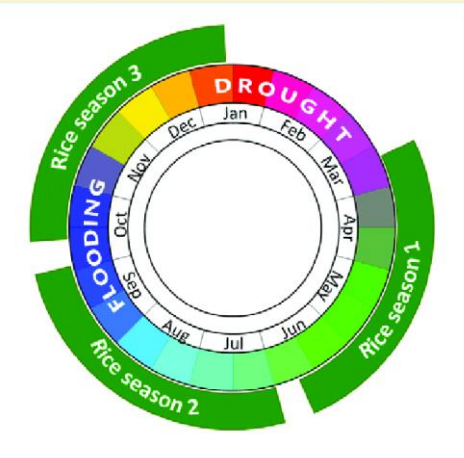
The facilitator instructs participants to:

- Fix the transparent films on the base map.
- Draw the boundaries of the areas that will potentially be damaged by the climate risk.
- Write the potential damage levels in the middle of the map polygons using different codes to distinguish the levels. Other remarks can be noted at the margins of the map.
- Place the map with the film on a flat surface and take photos perpendicularly for saving and storing information. It is recommended to use natural light to prevent reflections on the film.

The output of this step is fed into Step 3 to propose adaptation plans.

Example 2. For rice production in the MRD of Vietnam, there are two Climate-risks: drought-salinity intrusion (from January to March) and floods (from August to November). There are two scenarios of potential damage of these risks: (a) the moderate-damage year and (b) the extreme-damage year.

Temporal boundaries



Spatial boundaries

Step 3: Propose adaptation plans

Adaptation plans for a particular risk need to be developed for specific sites based on natural characteristics, products, infrastructure readiness and the risks map (output of Step 2).

Purpose:

Propose adaptation plans for each task in Step 2.1 (Table 2).

Output*:*

A map of adaptation plans for each task (Table 2).

Methods/tools:

To carry out this step, the main method is FGD (Appendix 1) which may be combined with the modeling method.

Materials and equipment required:

The base map (Step 2.1), the transparent film with risk boundaries and potential damage levels, and erasable colored pens.

Implementation process:

S3.1. Review the Climate-risk, its potential damage levels and boundaries

The facilitator guides participants to review the climate risk, its potential damages across the region and causes of the risk. This helps the participants build an overall picture of the region and synthesize information up to this step. Table 3 demonstrates a template that can be used to facilitate this process, and an example of the output.

Table 3: Description of risks and causes

Task: 1 Product: Rice Risk: Floods		Season: Rainy season Scenario: Moderate	
#	**Description of specific locations**	**Causes**	**Adaptation plan**
1	e.g. Double-rice area near the secondary school	No drainage canals, surrounded by high traffic road	(To be defined in Step S3.2)
…	…	…	

S3.2. Selection of adaptation plans

Adaptation plans need to be relevant to local characteristics, the risk and its potential damages. In general, there are two types of adaptation actions: construction and non-construction.

In this document, a construction action is understood as using artificial works to overcome and mitigate damages caused by climate-related hazards, such as building a dike system to limit inundation due to floods, building pumping stations and canal systems to tackle water shortage in dry seasons, building culverts to prevent saltwater intrusion to the fields, etc. A construction action is often highly efficient with measurable effects. However, it takes large investments and a long time for design and construction. It is, therefore, suitable for medium- and long-term adaptation plans and is a challenge for localities with limited financial resources.

A non-construction action for adaptive agriculture is understood as adjusting production activities according to the laws of nature towards ecosystem restoration and development, for examples: changing cropping structure, using climate-resilient varieties, adjusting cropping calendar, capacity building, etc. A non-construction action is relatively easily and quickly operated and highly relevant to local conditions. Therefore, this document encourages use of non-construction actions in developing adaptation plans for Climate-risks.

In this step, the facilitator supports participants to discuss adaptation actions for each specific area on the map listed in Table 3. The adaptation actions should be practical, and require minimum investments and time for deployment.

Table 4: Description of risks, causes and adaptation plans

Task: 1 Product: Rice Risk: Floods	Season: Rainy season Scenario: Moderate

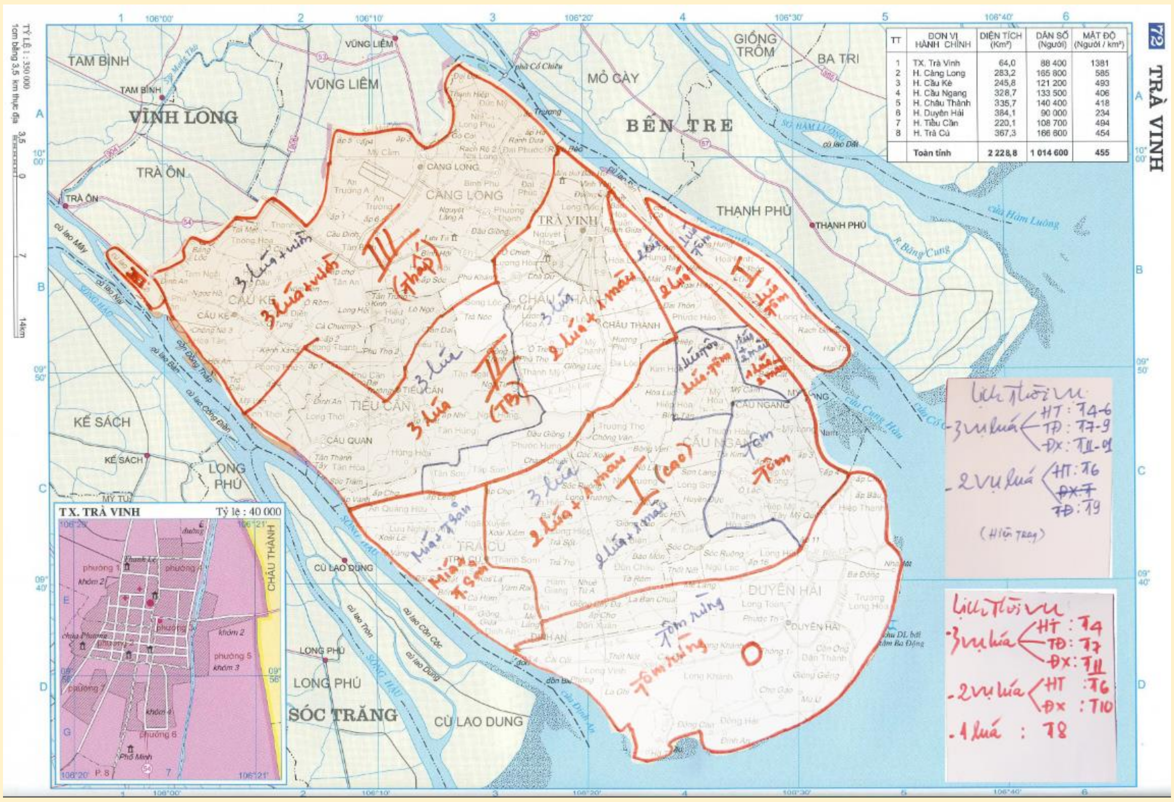
#	Description of specific locations	Causes	Adaptation plan
1	e.g. Double-rice area near the secondary school	No drainage canals, surrounded by high traffic road	- Plant 2 weeks earlier to avoid floods - Use short-duration varieties - Build pumping stations
…	…	…	

S3.3. Update adaptation plans on the map

- Participants note the current farming practices and seasons for each specific area on the risk map (S2.2) using markers, abbreviations and acronyms can be used if applicable. For example: use a red market to note "WS Rice $_{\text{(Nov.-Mar.)}}$" to refer to Winter-Spring rice season from November to March of the following year as a current cropping practice.
- Use markers of a different colour to note the adaptation plans on the same map. For example: use a blue marker to note "WS Rice $_{\text{(Oct.-Feb.)}}$" to refer to adjusting the Winter-Spring season to October – February as an adaptation action. Actions can be coded in Table 3 and noted using the same codes on the map.
- Place the map with the film on a flat surface and take photos perpendicularly for saving and storing information. Them, the film can be cleared for reuse afterwards.

Repeat Step 2.2.3 and Step 3 for all tasks defined in Table 2.

Example 3: Adaptation plans for drought and salinity intrusion for rice production in Tra Vinh province, Vietnam



The non- structural options proposed by local stakeholders of Tra Vinh province, Vietnam were: changing cropping pattern and rice planting calendar. These options are feasible with current conditions of infrastructure, finance and human capacity of the province. Particularly, areas in the Southern districts (code I) are highly prone to drought and salinity intrusion. The option is to change current triple rice (3 rice seasons per year) to double rice (rainy season) and cash crop (dry season). Because rice lands in the Northern part (codes II and III) are lowly prone to the risks, the triple rice pattern can be maintained but the planting month of Winter-Spring season is recommended to be shifted from December to November to avoid impact of the risks at the end of the season.

Step 4: Revise climate-smart maps and adaptation plans

Revising the initial maps of climate-risk and adaptation plans with a wider range of stakeholders is necessary to obtain a most feasible outputs.

Purpose:

Revise maps of climate-risks and adaptation plans with participation of larger group of local stakeholders.

Outputs:

Information on maps of climate-risks and adaptation plans are evaluated and finalized.

Materials and equipment required:

FGD and (Appendix 1) and/or KIP (Appendix 2). In this step, it is recommended that FGD is likely more efficient than KIP because it allows to get common understanding and agreement among stakeholders.

Before organizing FGD or KIP, initial maps with full descriptions should be digitalized and layout. The maps' layouts can be shown to stakeholders during discussion either in digital (i.e. Jpg, PDF or GIS layers) or in printed format.

- In case of using printed maps, the transparent film can be used to draw recommended changes. Other necessary materials are color markers and notes.
- In case of using digital maps, projector or large screen is necessary to present thematic maps.

Implementation process

S4.1. Sub-group discussion

Depending on number of participants, heterogeneity of the study area, participants can be split in smaller groups of 3-5 persons. Each group is assigned to discuss on climate-risks and associated adaptation plans for a particular area. For example, revising maps for a province can be done by sub-groups focusing on individual districts.

S4.2. Report on mapping process and initial outputs

Due to a large variation of stakeholders, briefing development process and initial maps to participants are definitely required. In this step, the facilitator briefly introduces the objectives, methods and obtained outputs of previous steps, and then guide participants to get familiar with the map as shown in Step 2.

S4.3. Refining the initial maps

During the discussion, the pre-prepared map layouts are presented to participants for their comments and suggestions for improvements. The facilitator can use supporting equipment to note recommended changes.

Map refining process can be done in following order:

- Evaluate the extent and level of climate-risks shown on the map.
- Refine climate-risk maps by season and scenario.
- Evaluate adaptation plans shown on the maps.
- Refine adaptation plans by season and scenario.

Changes can be updated directly on digital maps or documented or noted on paper maps for GIS processing.

Step 5: Regional integration of maps

Refining maps separately by sub-groups (Step 4) may result in conflicts over identified options among regions of the study area. For example, over storing water of the upstream provinces may lead to water shortage of the downstream provinces; or operation scheme of irrigation structures (i.e. dam, sluice gate) developed by a district may conflict with planting plan of the others, which use the same irrigation system. Therefore, the local adaptation plan needs to be integrated in the ecological and regional context. Management and sharing schemes of common resources (e.g. water, infrastructure) need to be discussed in this step.

Purpose:

Integrate the adaptation plans at local scale into ecological region scale.

Outputs

Regional maps of climate-risks and adaptation plans integrated and agreed by stakeholders.

Methods/tools

FGD (Appendix 1) or KIP (Appendix 2) can be used. The maps obtained from Step 4 can be shown to stakeholders during discussion either in digital (i.e. Jpg, PDF or GIS layers) or in printed format.

- In case of using printed maps, the transparent film can be used to draw recommended changes. Other necessary materials are color markers and notes.
- In case of using digital maps, projector or large screen is necessary to present thematic maps.

Implementation process

First, the local maps refined in Step 4 are presented to all stakeholders. Then, the facilitator guide stakeholders to match local maps into the ecological map. Mismatches can be discussed among stakeholders to make necessary adjustments based on stakeholders’ agreement. To adjust the map, follow instructions in S4.3. The final maps are standardized using the same projection, scale and base-map.

Example 4: Integrating adaptation plans for the Mekong River Delta

Participants match adaptation plans for the entire MRD region based on provincial maps

3. REFERENCES

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4. APPENDIX: Methods used in participatory practices

Appendix 1. Focus Group Discussion - FGD

Focus group discussion (FGD) is a qualitative data collection method that is organized for a group of 5 to 10 participants. This number of participants is large enough to obtain variation of people's opinion but still ensure the focus of the discussion. In FGD, guided questions can be pre-prepared. The optimal duration for a FGD is 30 to 45 minutes.

The advantage of FGD is easy to implement. It allows synthesizing individual opinions and come up with a common understanding and agreement. The disadvantage of FGD is that the outputs only reflect personal view of invited participants, which depends on their perception, education, expertise and experience. In addition, some members often tend to dominate or overwhelm others during discussion that lead to the bias outputs. Therefore, experienced facilitator is required to guide FGD's sections.

Before starting the first FGD section, brief of meeting purpose and self-introduction are necessary to get participants on the same page. The facilitator also need to asks for participants' consent of using the outputs of the FGD. The FGD may consist of several sections. Each section focus on one discussion topic. During the discussion, the facilitator encourages each participant to give their opinions and share experiences with others about a given topic.

Responsibility of the facilitator is to run though all pre-prepared guiding questions within the pre-set time frame. The facilitator also need to stimulate participants to share background information that associates to their viewpoints. The facilitator should not show bias attitude such as agreeing or criticizing individual opinions of participants. If there are contradict opinions, the Pairwise Priority Ranking method (Appendix 4) can be used to get agreement.

At the end of each section, the facilitator needs to summarize the discussion topic and highlight agreement points.

Appendix 2. Key Informant Panels

The Key Informant Panels (KIP) is a common method for exploring or verifying information, or collecting information from personal experience of experts. The advantage of this method is that the concerned issues are analyzed and evaluated by experts. The KIP is easy to implement and able to capture reliable information. However, the outputs of KIP may also be influenced by experts' bias.

To prepare for KIP, the research team should collect related information, and then make a list of relevant experts. In order to have a wide range of opinions, 7-15 experts should be invited. The invitation letter sent to experts must have clear explanation of the KIP purpose and expected outputs.

To start the KIP, the facilitator needs to describe background information (e.g. rationale, objectives of the discussion) to panelist, and clearly asks for their consent of using the information given by experts during the KIP. During the discussion, the facilitator invites panelists to provide their opinions about given topics. At the end of the discussion, the facilitator needs to summarize the discussion topic and highlight important points raised by panelists.

Appendix 3. Listing climate-risks

(Source: Simelton *et al.*, 2013)

Purpose	Make a list of major climate-risks that directly influent local agriculture production using perception and definition of participants.
Output	List of climate-risks, frequency of occurrence and possible level of damages.
Preparation	Explore types and seasons of major agriculture products before making the list of climate-risks.
Materials	Flipchart, paper sheet at A0 size, color markers and sticky notes.
Recommended duration	30 minutes

Implementation process

1. Prepare a table as in the example below on a A0 paper sheet to write down climate risks and their descriptions.
2. Fill information in the table according to local perception and definition during the Focus Group Discussion (Appendix 1) or Key Informant Panels (Appendix 2).
3. Summarize results of the discussion and use the ranking method (Appendix 4) to prioritize most concerned climate-risks.

Example of climate-risks

Climate-risks	Period of occurrence	Local definition
Flooding	September-October	When rice plants are submerged
Drought	February-March	Lacking of irrigation/rain water leads to the cracked soil surface, crop leaves turn yellow
Whirlwind	September-October	Strong wind leads to massive falling of crops

Appendix 4. Pairwise priority ranking

(Source: CARE, 2011)

Purpose	To rank multiple factors relative to each other according to level of importance based on defined criteria.
Output	Factors are ranked in the order from high to low importance.
Preparation	Make a matrix of factors to be ranked.
Materials	Flipchart, paper sheet at A0 size, color markers and sticky notes
Recommended duration	30 minutes.

Implementation process

1. Preliminarily screen factors to be ranked to reduce number of factor if needed (maximum number of factors should not excess 10).
2. Arrange factors in a matrix as shown in the table blow. First, each factor is assigned a code and then factors are arranged in the same order along X and Y axes of the matrix.
3. Determine the criteria for comparison (e.g. yield loss, level of damage, recovery cost, etc.)
4. Compare each factor (in column) with each other factor (in row). For each pair of factors, the one that has higher importance is fill in the intersecting cell. For example, if the flood risk is more concerned than the whirlwind risk then fill the number of the flood risk (number 1) in the intersecting cell of the 3th row and the 1st column.

Example of pairwise table

Factors	Flooding (Fl)	Drought (Dr)	Whirlwind (Wh)	Hoar-frost (Hf)	Heavy rain (HR)
Flooding (Fl)					
Drought (Dr)	FL				
Whirlwind (Wh)	FL	Dr			
Hoar-frost (Hf)	FL	Dr	Wh		
Heavy rain (HR)	FL	Dr	HR	HR	

5. Once all factors are compared, count number of times that each factor appears in the pairwise table and then rearrange the factors in another table according to frequency of their appearance in descending order. The factors with highest appearance frequency are the most important ones.

Prioritizing factors based on pairwise table

Factors	**Frequency**	**Priority**
Flooding	4	1
Drought	3	2
Heavy rain	2	3
Whirlwind	1	4
Hoar-frost	0	5

The **Initiative on Asian Mega-Deltas** (AMD) aims to create resilient, inclusive and productive deltas, which maintain socio-ecological integrity, adapt to climatic and other stressors, and support human prosperity and wellbeing, by removing systemic barriers to the scaling of transformative technologies and practices at community, national and regional levels.

Alliance

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