

# Development of a participatory approach for mapping climate risks and adaptive interventions (CS-MAP) in Vietnam's Mekong River Delta



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## ABSTRACT

The El Niño-Southern Oscillation (ENSO) in 2016 adversely affected Vietnam particularly in the Mekong River Delta (MRD), where more than 90% of the country's rice export is produced annually. During that time, salinity intrusion and drought significantly affected agricultural production in the area. Furthermore, flooding is another recurring event in the area that is increasing in frequency. An assessment conducted by CGIAR Centers showed that even as warnings were provided by the government for the 2016 ENSO, these were not translated into appropriate preparations and responsive actions for agriculture. To address this critical issue, the Department of Crop Production (DCP) of the Ministry of Agriculture and Rural Development (MARD) of Vietnam, and CGIAR Research Program on Climate Change, Agriculture and Food Security in Southeast Asia (CCAFS-SEA) collaborated to develop and test a participatory approach for mapping climate risks and adaptive interventions (CS-MAP) to recognize climate-related risks, identify potentially affected areas and develop regional and provincial adaptation plans for rice production. The CS-MAP is a participatory approach involving experts from various local and national offices for: (1) identifying climate-related risks; (2) delineating affected areas and risk levels; (3) proposing corresponding adaptive plans; (4) fine tuning and verifying proposed measures; and (5) developing integrated provincial and regional adaptation plans. Risks and adaptive interventions maps were developed for normal and ENSO years by using technical data (i.e. topography and hydrology), infrastructures (i.e. dikes, road and canals), and local observations. CS-MAP is now in various stages of development and implementation in 13 MRD provinces highlighting the organizational uptake and integration of the approach.

## 1. Introduction

Participatory mapping approaches are increasingly adapted for engaging stakeholders in environmental and resource management as it allows integration of stakeholder knowledge and preferences (Lynam et al., 2007). Integrating scientific and local knowledge is critical in managing climatic challenges and the use of participatory mapping as an appropriate way is emerging in this research theme. There is a growing demand for spatially explicit climate change management information at local scale (Preston

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et al., 2011). Until recently, participatory mapping tools and approaches are used for climatic vulnerability or risk assessments (Preston et al., 2011; Hung and Chen, 2013; McElwee et al., 2016), and not widely used for climatic risk and adaptation interventions. There are some efforts in using mapping tools in disaster risk reduction (Gupta et al., 2002; Phong et al., 2008; Cadag and Gaillard, 2012; Kelman et al., 2012) but studies reporting its' use in large-scale climate adaptation is lacking and the current work attempts to address the void. It is expected to create a mid-path between predominantly science-led or predominantly community-led adaptation approaches (Gustafson et al., 2017).

The Mekong River Delta (MRD) is the rice basket of Vietnam producing 56% of the total domestic rice production and accounting for 90% of Vietnam's rice export. Over 1.7 million hectares of land, more than half of the total arable land in the region, are being used for rice production (GSO, 2016). In the MRD, rice can be grown in three cropping seasons: the Winter-Spring season (November to February), the Summer-Autumn season (April to July) and the Autumn-Winter season (August to November). The rice production system that has a significant role in food security of the country, is increasingly under pressure from climatic related impacts such as salinity intrusion due to sea level rise (Renaud et al., 2014), increasing number of drought events in El Niño years (1997–1998, 2004–2005, 2010, and 2014–2016) (DMC, 2016) and flood events during La Niña events. In 2016, El Niño reduced the rice production by 700,000 tons and affected 339 thousand ha of the winter-spring rice cultivation area (21.8% of the total area in the MRD). In 2011, the severe flood damaged 27,000 ha of crops, of which crop yield of 10,000 ha was completely lost (Ngoc Anh, 2011). The projected sea-level rise of 100 cm by 2100 could flood upto 40% of total area of the delta. Currently, it is important to devise ways for adapting to these multiple climatic stressors (Birkmann, 2011).

In response to growing need for climatic resilience in the delta, a number of programs have been conducted by international and national organizations to pursue climate resilient sustainable development of agriculture in the MRD. Starting from 2010, the Mekong Delta Plan (Govs, 2013) has been developed, presenting 'no-regret' and priority measures for long-term adaptation in upper, middle, and coastal zones of the region. The recommendations mostly focus on structural interventions, such as upgrading systems for flood protection, flood diversion, salinity intrusion prevention, and fresh water storage. In accordance with the key recommendations given in the Mekong Delta Plan, an on-going national program (World Bank, 2016) targets the improvement of infrastructure, information system, and capacity building to enhance climate-smart planning, and integrate land and water management and sustainable livelihoods in nine provinces of the MRD. The Vietnam government also invests in sustainable rice-based systems in the MRD (World Bank, 2015) to support large-scale improvement of rice-farming practices. However, the main focuses are capacity building (i.e. training and demonstration), extension skills, equipment and facility support, infrastructure, and financing. All the activities focusing structural adaptation measures are primarily carried out by state (Birkmann, 2011) while non-structural actions concerning adaptation of farming practices are less coordinated. In this article risk and adaptation mapping exercise is presented as a possible approach to meet the need of a mechanism for coordinating adaptation measures, especially the non-structural interventions. The following sections describe the methodology and results of the exercise.

## 2. Methodology

### 2.1. The study area and problem setting

The current participatory adaptation mapping exercise was done for the MRD (Fig. 1), which is highly vulnerable to climatic changes and extreme events such as drought, salinity intrusion and floods (Dang et al., 2014). Every year, the delta experiences the effects of salinity intrusion and drought in ten provinces during the winter-spring season and flooding in nice provinces during the autumn-winter season. Six out of 13 MRD's provinces have to face to such climate risks within a year. Climatic phenomena like El Niño and La Niña exacerbates those risks and their impacts. Although climate-related problems in the MRD are clearly recognized, damage to agriculture, especially rice production in the region is not addressed on a larger scale.

In recent years, a number of solutions have been introduced in the MRD to pursue sustainable development of rice production of the region (Govs, 2013; World Bank, 2015, 2016). However, many of them mainly focused on building institutional capacity, improving infrastructure (i.e. protected dike, sluice gates, irrigation canals and pumping station) and facilitating market opportunities; and few considered non-structural measures such as shifting sowing/transplanting calendar, using risk-tolerant crop varieties, changing cropping rotation and adjusting irrigation schedule that are practicable for rice farmers. A CGIAR led assessment (CGIAR, 2016) found that official warnings of expected salinity intrusion and drought problems during the winter-spring season of 2016 were conveyed to the farmers early. Structural measures were well prepared; however, these warnings were not translated to adjusted agricultural production on a larger scale. It highlighted the need of approaches and mechanisms that can translate the warnings into effective adaptive actions matching with the scale of perceived risk. The participatory mapping approaches are expected to meet such a demand. Though there exist attempts to utilize local knowledge to improve disaster maps in Vietnam, there are few attempts to map the non-structural adaptive interventions at farm level and understanding the preferences of stakeholders (Phong et al., 2008). The current study describes the development of a participatory approach for mapping climate risks and adaptive interventions in a resolution that allows their implementation by local authorities. It is to be noted that proposed measures by many of the modeling based studies on drought, flooding or salinization were not detailed enough for implementation at provincial level (Leskens et al., 2014). These studies ignore the fact that adaptation is a complex process that depends on type of climatic stress, the characteristics of systems, scale of adaptation and portfolio of adaptive responses (Dang et al., 2014). The current work aims to develop adaptive interventions maps for rice production that are scaled to climatic risks, consider local specific conditions and manage the conflicts in land and water management in different provinces. These map based approach is aimed at supporting climate-smart management of rice production in the Mekong River Delta by integrating science based data with stakeholder preferences and perspectives (Gustafson

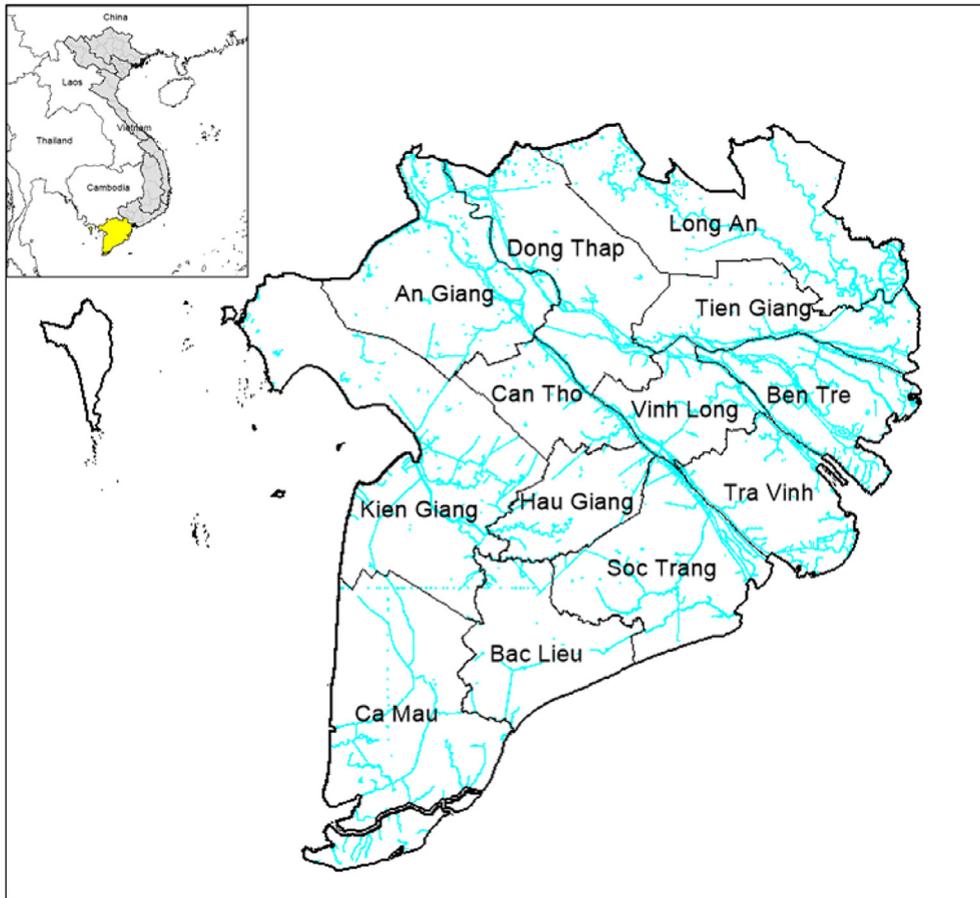


Fig. 1. Location of the Mekong River Delta in the map of Vietnam.

et al., 2017). The approach development activity was intended to support department of crop production and MRD's provinces in recognizing climate-related risks and developing regional and provincial climate change adaptation plans for rice sector. Specifically, the project aimed to:

1. Use participatory mapping to identify of salinity intrusion and flooding risks for all 13 provinces of the MRD;
2. Map the possible adaptation plans for rice production taking into consideration the local specific conditions and the conflicts in land and water management by different provinces using the participatory process and hence support climate-smart management of rice production in the delta.

### 2.2. The science and stakeholder information

Long-term and short-term weather forecast and climatic trends in the Mekong River Delta were provided by the National Centre for Hydro-Meteorological Forecasting (NCHMF), and the Southern Hydro-Meteorological Center (SHMC), respectively; and the responsive options for water resource management proposed by the Southern Institute of Water Resources Research (SIWRR). Effects of climate change on land use, especially the future effects of flooding and salinity intrusion to rice-based cropping systems, in the region were given by CLUES project (Hoanh, 2013; Ngo Dang et al., 2016). The provincial topographic maps at scale of 1:100,000 that are detailed enough to see landmarks, infrastructures, and land use patterns at district level, were used as the base maps. The most recent land-use map was also collected to identify rice lands and rice-based cropping systems of each province and of the MRD region. All maps were printed to facilitate discussion among stakeholders.

### 2.3. Participatory mapping

In this study, we referred the participatory spatial planning method introduced by McCall and Dunn (2012) to develop the participatory approach for mapping climate risks and adaptive interventions and considered local knowledge as the backbone of the participatory mapping process. In the participatory process, experts and officials from the national and provincial institutions and international organizations identified problems and then explored appropriate local-specific-solutions through several multi-

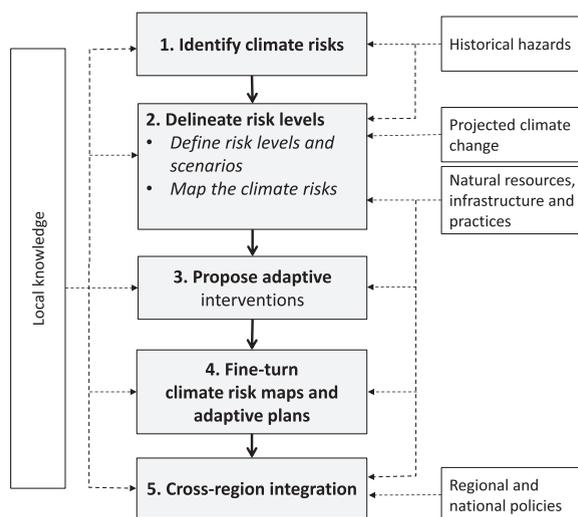


Fig. 2. Participatory process in mapping climate risks and adaptive interventions.

stakeholders dialogues. The process of the participatory mapping approach is summarized in Fig. 2.

In order to have common understanding of climate risks in the region, the first dialogue is conducted for a wide range of stakeholders including provincial agencies (e.g. crop production office, hydrological management office, hydrological and meteorological stations), research institutes, universities and a high-level management institution (i.e. Ministry of Agriculture and Rural Development). Participants were grouped by province. Each group had about 10 members, including 8 provincial officials and 2 facilitators. The gender balance within a group was not considered in this dialogue.

The first dialogue was split into four sections. In the first section, members of each group report recent crop damages and yield losses caused by climate-related hazards in the province, and together with facilitators to recognize potential risks in the future. A guideline for discussion developed by DCP and CCAFS was used by facilitators. The important guiding questions for the discussion were “what were the main causes of recent damage on rice production?”, “when did the hazards happen?”, “which hazards relate to impacts of climate change?”, “where in the province that rice production will likely be affected by the future hazards given current situation of natural resources, infrastructure and management scheme?”. Outputs of this section were the list of climate risks and their threat in rice production of the province. The outputs of group discussion were then presented to all participants.

The second section was organized for all stakeholders to define risk scenarios and levels. The experiences of provincial officials on historical climate-related hazards in the region were then used by to build risk scenarios, namely (a) normal event: moderate intensity and duration of the hazard and (b) severe event: extreme intensity and prolong duration of the hazard. They also discussed to quantify thresholds of risk levels (i.e. low, medium and high risk) based on their background and understanding.

The common understanding of climate risks and risk levels and scenarios were used in the next section to develop climate risk maps. Paper maps and transparent plastic layers were used to facilitate discussion and mapping process. Participants identified areas that are exposed and sensitive to the recognized risks in the province. Boundary of potential affected areas was delineated directly on the plastic layers. Provincial officials analyzed situation of existing infrastructures, such as protection dykes, irrigation and drainage canals, sluice gates, pumping stations, relative elevation of rice fields, among others, and assumed the level of damage of rice planting areas if hazards occur. Analysis was made following the two defined scenarios (i.e. the normal and the severe event). Latest extreme events and their affected areas were taken into consideration to localize area and intensity of the risks. To be noted that risk level refers to the possible loss in rice production due to the impacts of the hazard in relation with the current status of natural resources (i.e. land and irrigation water), infrastructure (i.e. protected dike, sluice gates and irrigation canals) and management practices (i.e. local rice varieties, transplanting/sowing methods and irrigation scheme). Outputs of this mapping work were separate risk map layers with detailed notations.

In the final section of the first dialogue, the risk maps built by stakeholders were used as basic materials for developing adaptive interventions. Stakeholders were asked to propose non-structural interventions that are practicable for the province, corresponding to each of risk scenarios. The proposed interventions were described for each potential affected area and mapped on separated map layers.

It is the fact that risk maps and adaptive interventions developed through above group discussions may not be representative due to bias inputs of invited participants. Other local experts, who did not attend the previous dialogues, may have different opinion on climate risks and solutions. Therefore, fine-tuning the result with other local stakeholders is needed. Given this situation, a second multi-stakeholders dialogue was organized in the individual provinces. In each province, participants of previous dialogue and officials of provincial agencies were invited to participate in evaluation of risk maps and adaptive interventions. Through this meeting, the risk maps and proposed adaptive interventions were further refined and updated. The revised maps were digitized using Geographic Information System (GIS) tools. The second multi-stakeholders dialogue can be repeated several times if there is any

argument.

The third multi-stakeholders dialogue was organized to integrate adaptive interventions of individual province into ecological zone and regional plans. All stakeholders attended the first dialogue were invited to join a regional workshop on the integration issues. In this workshop, participants were grouped by ecological zones. Each zone includes adjacent provinces that have similar bio-physical condition and share the same natural resources (e.g. irrigation water). Cross-province issues related to climate change risk management and action plans for implementation of adaptive intervention, which were emerged during the group discussion, were reported to policy makers, researchers, and other stakeholders. The integration plan was then developed for each province and for the whole region, taking into consideration the regional and national policies.

The CS-MAP was piloted in a province of the MRD to (1) explore common understanding of flood and salinity intrusion risks; (2) see how local knowledge can be used in developing risk maps; and (3) adjust the participatory spatial planning method with the context of rice production in the MRD. Key informants from four administrative scales (i.e. province, district, commune, and village), who are familiar with hydrological and cropping systems, were invited to participate in the mapping process. Findings of the pilot test were presented to experts and officials of DCP to refine the CS-MAP components and processes.

#### 2.4. Pilot of CS-MAP

The CS-MAP approach was piloted in early October 2016 at four administrative levels: province (Bac Lieu), district (Vinh Loi), commune (Chau Thoi), and village (Tra Hat) of Bac Lieu province. There were different understanding and definition of climate-related risks depending on the key informant's expertise and perception. In case of salinization, officials from Hydrology Management Office (HMO) categorized risk level as the frequency of salinity intrusion and concentration of dissolved salts in irrigation water. Accordingly, the intrusion of water with salt concentration greater than 4 g/L is considered as high risk for rice. This is in accordance with the results of researches on saline-tolerance capacity of rice. Areas that have salinity intrusion occurred every year are also considered as the high risk. According to the officials of the Agricultural Management Office (AMO) and the CPO, concentration of dissolved salts is not an important factor to define risk. A certain concentration level can be a high risk for double or triple rice system but may not be a major concern for single rice or rice-shrimp system. From their point of view, the start and duration of salinity intrusion significantly define levels of rice yield reduction. This is also true because the high saline-tolerant rice varieties cannot sustain under long saline period (i.e. more than 10 days with concentration of 4 g/l).

In protected areas with dykes, shortage of fresh water for irrigation during saline period was another issue raised by the key informants. Experience from the salinity intrusion event occurred during the winter-spring season (2016) shows that rice yield in many well-protected (dykes) areas dropped significantly because of fresh water deficit for irrigation rather than saline water intrusion. There are similar issues for identifying and categorizing flooding risk. Frequency, depth, duration, and timing of floods should be the factors to be considered. These caused a lot of confusion in the development of the risk maps at any administrative scale. Using multi-factor risk assessment is difficult for local officials and managers because they are not familiar with technical terms and parameters that are often used by scientists. Furthermore, the key informants have different backgrounds and perspectives on risks and responsive strategies. Officials from HMO are very familiar with the details of irrigation system and can easily delineate affected areas, but lack knowledge of cropping system and crop production. Contrarily, people from Crop Production Office (CPO) tend to know about crop-related issues better than hydrological systems.

Other key participants referred risk levels as the reduction of rice yield caused by flood or salinity intrusion, following the recent assessment guidelines of Ministry of Agriculture and Rural Development (MARD). The guidelines have been developed to estimate damage and provide relief to the affected areas. Accordingly, there are three levels of loss: serious (reduction of more than 70% of rice yield), medium (from 30% to 70% of rice yield), and low (below 30% of rice yield). These scales are made for the ease of understanding for local officials. Whereby, the intensity and duration factors of the extreme climate events can largely affect the level of yield loss can be tracked. Findings from the pilot of CS-MAP were presented to the experts and officials of DCP-MARD through a consultation meeting. The consensus was that CS-MAP needs to address four risk levels, namely very high risk: expected loss of more than 70% of rice production, medium to high risk: expected loss of 30%–70% of rice production, low to medium risk: expected loss of less than 30% of rice production and not affected: no impact to rice production. No impact scenario means the rice area is fully protected or rice-based system has transformed to other resilient farming systems. For the ministry of rural development, drought and salinity intrusion are two phenomena of a single extreme event and hence potential reduction of rice production that is resulted from drought or salinity intrusion can be combined as a single risk.

The standardized CS-MAP was developed for all 13 MRD's provinces. The initial outputs were improved and verified with the provincial experts through separate meetings in each province. The final risk maps and adaptation plans developed by the provinces were combined and discussed to identify the potentials and constraints in the actual implementation, considering the regional context.

### 3. Results

The first multi-stakeholders dialogue was organized in Can Tho City on 17th and 18th November 2016 with attendance of about 130 participants from Department of Agriculture and Rural Development (DARD) of 13 MRD's provinces, Department of Crop Production (DCP), eight national research institutes, two hydro-meteorological centers, and two international organizations. At least five participants from each province were attended the dialogue, including a leader of provincial DARD, leaders of the Crop Production and Plant Protection Office and Hydrological Management Office, and representatives of local Hydro-Meteorological

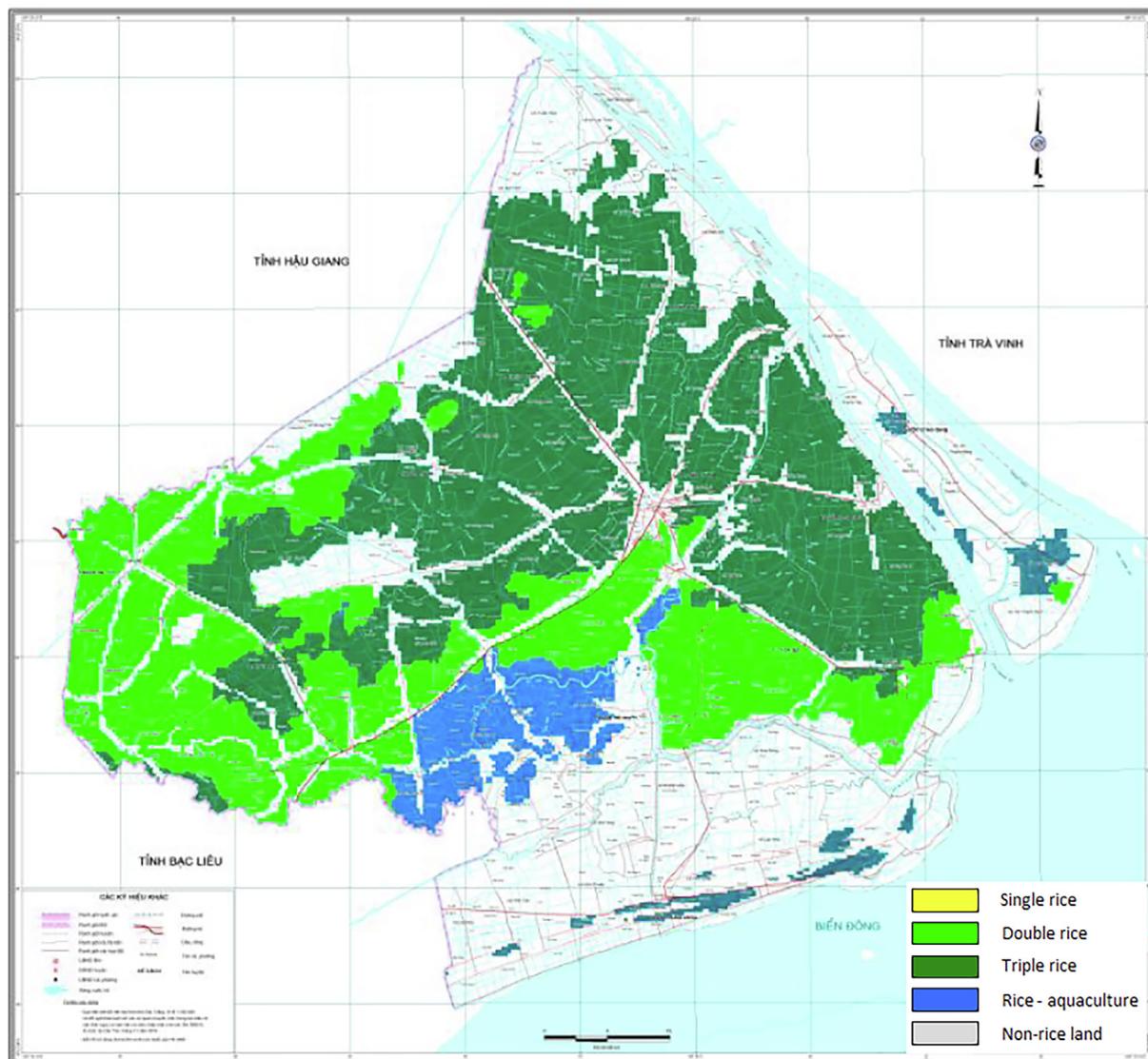


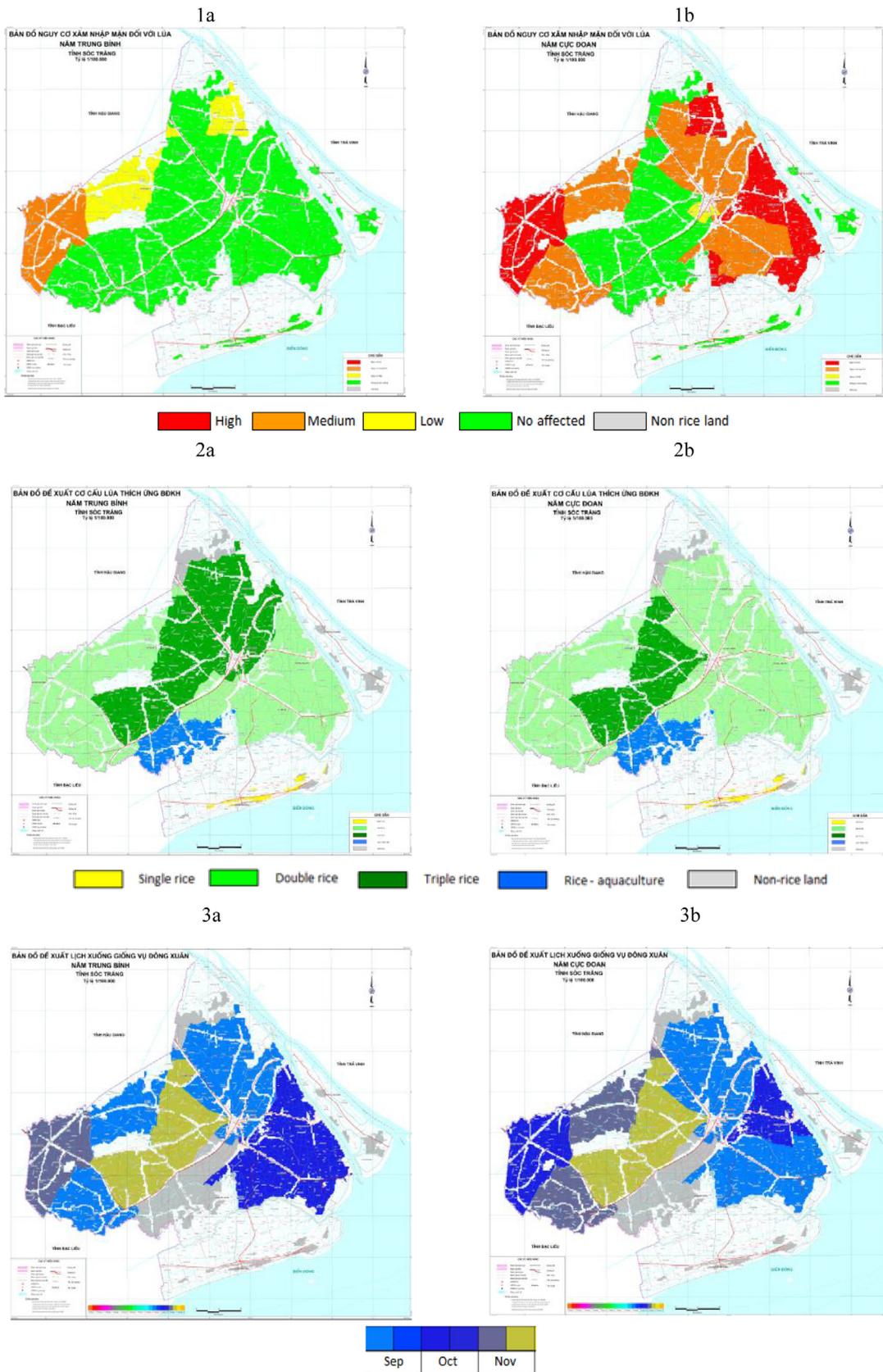
Fig. 3. Maps of rice-based systems in 2010 of Soc Trang province.

Station. Maps of climate risks and adaptive interventions developed during this dialogue were presented in several meetings in individual provinces from December 2016 to June 2017. In July 2017, the final provincial maps were presented in a regional workshop to discuss on regional integration.

The followings are results obtained at Soc Trang, a coastal province prone to drought and salinity intrusion, Dong Thap, an upstream province prone to season floods.

Fig. 3 shows the map of rice-based system in 2010 of Soc Trang, a coastal province of the MRD. More than 50% of the rice lands were used for triple-rice cropping (dark green regions), which includes winter-spring rice (November to February), summer-autumn rice (April to July), and autumn-winter rice (August to November). The remaining rice areas are for single (yellow regions) and double cropped rice (light green regions), and rice-shrimp rotation (blue regions). As being located in the coastal zone and close to river mouths, the province is exposed to the impacts of salinity intrusion, especially during ENSO years.

Fig. 4 presents the risk maps developed by the CS-MAP exercise. In normal years, salinity intrusion may only occur from February to March in the north and west parts of the province. When this happens, rice yield in the winter-spring season can reduce up to 70% (orange region) in Nga Nam district and below 30% (yellow region) in My Tu and Ke Sach districts. Other rice areas are not affected (green region). In severe years (e.g. 2015–2016), there is a high possibility that about two-third of rice lands of the province is damaged by saline water. Most of rice fields along Hau River and close to Bac Lieu province are under the high risk (red region), which may result to yield loss of more than 70%. Risk level of some areas also rises from medium in normal years to high when extreme salinity intrusion occurs. In addition, a large rice land belonging to Thanh Tri, My Xuyen, and Chau Thanh districts in the center of the province could be at medium risk due to intrusion of saline water in the irrigation canals. Only rice lands located in the



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**Fig. 4.** Maps of salinity intrusion risk in (1a) normal years and in (1b) severe years, and proposed adaptive cropping systems (2a and 2b) and planting calendar (3a and 3b) in the two scenarios, respectively.

middle of the province are not affected.

With awareness of the increasing climatic challenges in the future, participants from Soc Trang province have proposed two adaptive plans corresponding to two salinity intrusion scenarios. Fig. 4 present the CS-MAP exercise to develop spatially explicit adaptive cropping systems. To minimize yield loss due to salinity intrusion, the province will shift one-third and two-third area of current triple-rice to double-rice in normal years and in severe years, respectively. Rice in the high-risk seasons can be replaced with cash crops. Together with changes in cropping system, planting time of rice seasons will also be adjusted. Fig. 4 also presents the CS-MAP exercise to spatial specification of changing crop calendars. Particularly, winter-spring rice needs to start between September and October, about a month earlier than current planting calendar, to avoid drought and salinization problems at the end of the season.

Fig. 5 presents maps of flooding risk and adaptation plans of Dong Thap, a province in the submergence prone of MRD. Two first maps in the Fig. 5 present the outcome of CS-MAP exercise in the province to spatially delineate flooding risks. These maps clearly show that most of rice acreage of the province is under flooding risk. The well protected area is very small, located in the north of the province. The high risk area covers nearly a half of rice land in normal years. It can be expanded to the southern part in case of severe flood event.

At present, despite of seasonal flooding problem, triple rice cropping is widely practiced in the province. As the proposed plan, the autumn-winter rice season will be skipped in severe flooding years to avoid economic loss. As the result, a substantial portion of areas practicing of triple rice needs to be converted to double rice in severe flooding years. In the remaining area, planting calendar can be adjusted to minimize damages caused by unpredicted floods. Fig. 5 also presents the planting calendar in normal years. Accordingly, the autumn-winter rice can be planted from the May to June to make sure that rice is completely harvested before the flooding season (September to November).

Similar maps and plans have been developed for individual provinces of the MRD through the CS-MAP process provided in Fig. 2.

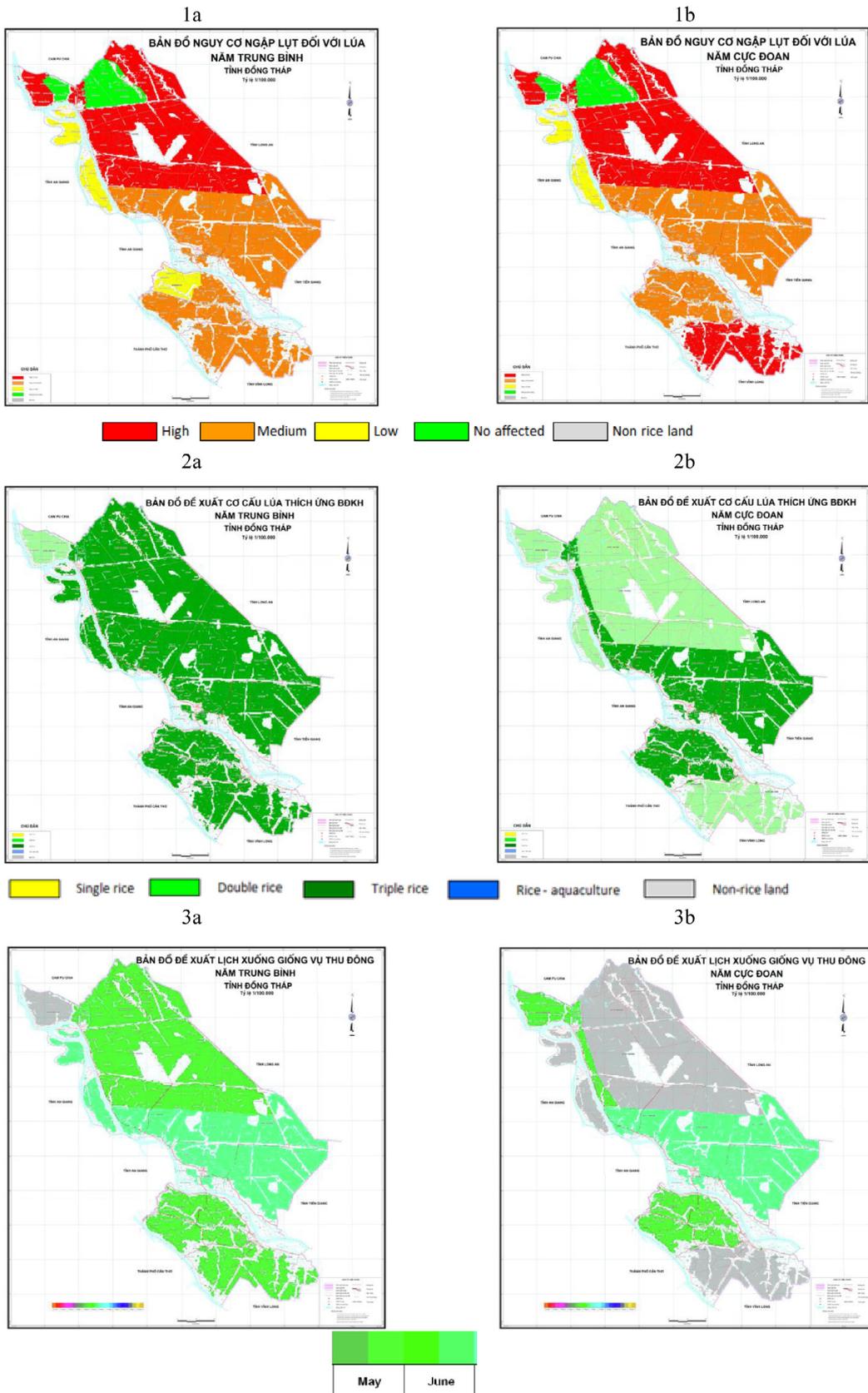
## 4. Discussion

### 4.1. Cross provincial issues

The Mekong River Delta contributes more than a half of the total domestic rice production and more than 90% of Vietnam's rice export annually. Therefore, maintaining rice production under increasing impact of climate change, reducing input costs through large scale mechanization and irrigation management and ensuring the stable market price are the major priorities of the farmers, managers and policy makers. In the MRD, agriculture production of adjacent provinces is interlinked to each other through their land use decisions, water sharing scheme, and farming practice. For example, water holding strategy of upstream provinces may lead to water shortages in downstream regions, or improper shrimp farming techniques of coastal regions may result in intrusion of saline water in rice lands. The inter-linkages are often ignored in studies focus single provinces. Given the regional context, changes in rice-based system and rice planting calendar of a province have to be in accordance with other adjacent provinces. Therefore, maps and plans have to be combined to present the regional picture. In July 2017, combined maps and provincial plans were presented to participants from provincial DARDs, researchers, and experts in the third multi-stakeholders dialogue. Participants were grouped according to the three ecological zones of the MRD, namely the upper delta zone: An Giang, Kien Giang, Dong Thap, and Long An provinces, the middle delta zone: Can Tho, Vinh Long, Tien Giang, and Hau Giang provinces, the lower delta zone: Ca Mau, Bac Lieu, Soc Trang, Tra Vinh, and Ben Tre provinces. The main discussion points related to cross-provincial issues were: updating the on-going structural interventions and research projects of provinces; identifying potential mismatch of land use plan and water management among provinces; analysing the possibility of cross-provincial solutions for common climate-related problems and development of sharing platform for adjacent provinces to enhance co-benefits from the individual changes; and produce the regional implementation plan. Fig. 6 shows how maps were merged into a salinity intrusion risk map and flooding risk map of whole MRD region. Fig. 6 presents the regional maps of salinity intrusion and flooding risks for rice production in severe years of the MRD as the final output.

### 4.2. Recommendations for improvement

Cross-provincial intervention does not only mean integration of rice production but should also include sharing of resources, especially irrigation water, to ensure regional benefit. Therefore, sowing/transplanting date, irrigation or drainage schedule, and structural investments of a province have to be shared to others. Cross-provincial intervention needs a management unit. It can be combined with the South-West Steering Committee, a key regional political institution in Vietnam, which has a relevant mandate. Beyond the cross-provincial interventions for climate-related risk management, it is also needed to build linkages among private sectors, farmers, scientists, and the government to promote sustainable rice production in the region. Regarding the risk maps, provinces need to downscale and supplement local specific factors, such as acid sulphate soil, drainage and irrigation conditions, to improve map quality and corresponding adaptive plans. Beside climatic early warning and weather forecast, prediction of future market price also needs to be done because it is important information in the planning and decision making process. For sustainable



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Fig. 5. Maps of flooding risk in (1a) normal year and in (1b) severe year, and proposed adaptive cropping systems (2a and 2b) and planting calendar (3a and 3b) in the two scenarios, respectively.

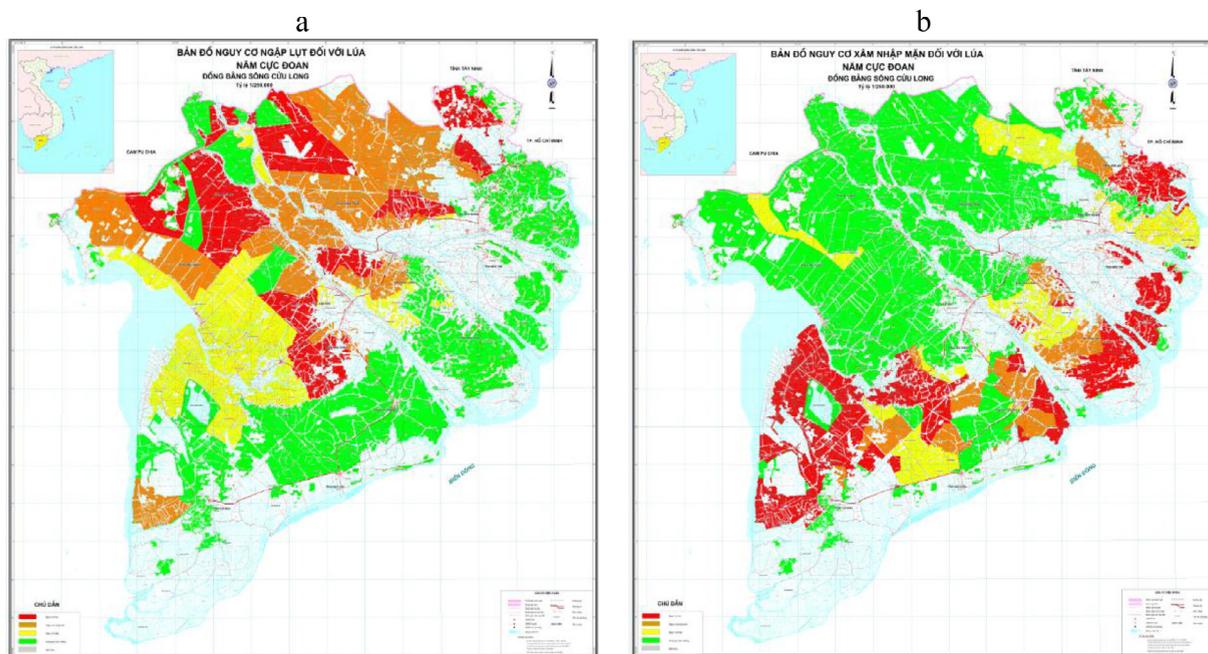


Fig. 6. Map of flooding (a) and salinity intrusion (b) risks for rice production in severe years of the MRD at scale of 1:250,000.

rice production of the MRD, changing cropping calendar and system cannot be done alone but have to be implemented together with structural measures, water saving technologies, tolerant varieties, and policy and institution. These recommendations have been considered by the DCP for future development of directions and management programs.

In general, CS-MAP was well developed and implemented for rice production in the MRD. However, this method initially targets provincial officials and researchers as the main stakeholders. Private sectors and farmers, the two actors that play very important role in rice production, were not involved in the participatory mapping process. To engage those stakeholders, CS-MAP needs to be downscaled to lower administrative levels (i.e. villages or communities). Another limitation is that quality of output risk maps and adaptive interventions is much depends on expertise and perception of the invited stakeholders. They may bring their bias in identifying problems as well as proposing solutions. This can only be minimized by refining the CS-MAP outputs several rounds with different groups of local stakeholders when organizing the second multi-stakeholders dialogue.

#### 4.3. Initial outcomes

Results obtained from the implementation of CS-MAP were highly appreciated by the officials of DCP and provincial DARD. The maps and proposed adaptation plans are considered as important information in developing the short, medium, and long term agricultural land use plans of the individual provinces, as well as of the whole MRD. On 22 February 2017, the DCP issued the official Circular number 184/TT-CLT (Appendix 2) to request the MRD's provinces to develop action plan for actual implementation of adaptive rice-based systems and cropping calendar. It shows the credibility and authority of the produced maps and the effectiveness as a communication and adaptation planning approach (Hauck et al., 2013). The feedback and refining loops built within the five step procedure discussion officials helped in avoiding the post-development criticisms of the CS-MAP. The process also allowed the map construction from local to regional scales.

Responding to DCP's request, several provinces have implemented their proposed plans. Tien Giang, a coastal province that is frequently affected by salinity intrusion and tidal rise, has integrated the adaptive rice-based systems in their land use planning. This was done under the provincial program titled "Cutting and shifting cropping system and calendar for eastern districts of Tien Giang province up to 2025". Accordingly, the eastern districts will only apply double rice cropping or rice-cash crops rotation. The change will be implemented on more than 26,000 ha of agriculture land, including 23,000 ha for shifting triple rice to double rice, and 3000 ha for converting rice land to fruit trees. In addition, shifting rice planting date was also planned for 4128 ha. The shift of planting dates in this area itself could have saved more than 3 million USD (taking average loss of 2.5 tons per ha by salinization) in the dry season. At present, the province has applied the changes for 15,217 ha, approximately 59% of the planned area in the map. To cope with annual flooding (from October to November), An Giang province has decided to shift the autumn-winter rice season earlier for both outside and inside dyke system to ensure safe harvest before October. Three provinces (Long An, Dong Thap, and Soc Trang)

are also continuing to refine the maps on their own initiative.

In 2017, CCAFS SEA continued to support provinces on CS-MAP application and following emerging outcomes. Further up-scaling was supported by MARD Decision QD-BNN-KH 1915 issued on May 28, 2018. Recently, the DCP of the Ministry of Agriculture and Rural Development issued a directive to adjust the planting calendar in the rice production areas in the MRD to avoid salinity intrusion that is expected to aggravate with the 2019 El Nino. The adjustments were guided by the climate-risk related maps and adaptive intervention developed by the 13 provinces. This was implemented following the directive of MARD Vice Minister Le Quoc Doanh last August 2019 during the rice production planning meeting for the DCP to monitor the upcoming El Nino and apply the CS-MAP for possible adjustments in the rice planting calendar during the Winter-Spring season (Announcement no. 6194/TB-BNN-VP). As per recent the report by the 13 provincial DARDs, areas planting earlier (November 2018) reached 802,702 ha (from 174,538 ha in 2017) and a reduction in later planting (December to February) to 596,543 (from 1,226,961 ha). This covers more than 600,000 ha planting earlier that has enabled the farmers to avoid the adverse effects of salinity intrusion that is common during Winter-Spring rice planting season and aggravated by the El Nino.

## 5. Conclusions

The climate risks and adaptive interventions maps is generated through a participatory approach that actively engages experts from various local and national offices to come up with implementable local solutions to climate change related impacts. It involves (1) identifying climate-related risks; (2) delineating affected areas and risk levels; (3) proposing corresponding adaptive plans; (4) fine tuning and verifying proposed measures; and (5) developing integrated provincial and regional adaptation plans. The CS-MAP is a useful approach to help agricultural managers and planners better delineate location and time of climate-related risks; and identify specific response measures. It integrates scientific findings and local expert knowledge. The exercise showed that practical risk maps and adaptation options can be quickly developed at low costs. It is to be noted that the facilitators could act as intermediaries between scientists and ensure the communication among the stakeholders.

With CS-MAP, provinces can conveniently develop their own adaptive plans. Local specific conditions and cross provincial concerns are better integrated in land use decision making and, therefore, solutions are more relevant to local context. Among the common adaptive options proposed by provinces include changing rice-based cropping systems and sowing/transplanting calendars. Some provinces are implementing the adopted measures and developing the corresponding monitoring and reporting tools. It can also be further downscaled to district and commune scale to improve precision. The approach was successfully embedded into the administrative system and it could be due to the direct involvement of the personnel in the development of the CS-MAP. It could also be the fact the mapping approach could capture the organizational requirements in addition to acting as a communication and management mechanism. It ensured the usability and usefulness of the approach.

The participatory development of climate-related risk maps and adaptive plan in this study was developed for rice production but has potential to be extended for other crops, aquaculture, and livestock. The provinces and districts can also continue to refine the maps for various purposes including poverty mapping, relief operations, among others reflecting the utility of the participatory adaptation mapping exercise. There is also a need of continuous research support to the CS-MAP to make sure that they are updated and relevant and can accommodate newer technologies, climatic threats or system changes.

## Conflict of interest

None.

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