Review of IRRI studies in view of informing Vietnam's NDC revision:

GHG mitigation potential in Vietnam's rice sector through outscaling of water-saving techniques

1. Background

In Vietnam, multiple rice crops per year make up an annual planted area of 7.7 million ha, of which more than 90% (7 million ha) are irrigated (GSO, 2017). Irrigated rice cultivation has been recognized as a concerning source of GHG emission of the country, which contributed 42.6 Mt CO2eq in 2013 (MoNRE, 2019). Therefore, reducing GHG emissions from the rice sector is one of Vietnam's mitigation priorities in its NDC.

The country has prioritized alternate wetting and drying (AWD) and other water-saving techniques (WSTs) as a key option for GHG reduction in the agriculture sector (MoNRE, 2015; MoNRE, 2019). Accordingly, Vietnam expects to implement AWD on up to 1.5 million ha in in 2030 together with other measures to be able to reduce GHG emission from rice sector (MoNRE, 2015). MARD (2016) has further refined the targets and added the mid-season drainage (MSD) technique as an additional option for GHG mitigation. Implementation of these options in agriculture is expected to contribute to the reduction of national GHG emissions by 8% below the business as-usual (BAU) in 2030 with national capacity, and could be 25% with sufficient international support (GoV, 2016).

In practice, the suitability of rice land for AWD implementation may spatially and temporally vary due to heterogeneous climatic and bio-physical conditions in the country. Therefore, mapping AWD suitability became a need to inform the development of national mitigation plans.

2. Climatic AWD suitability maps

Starting from 2016, the International Rice Research Institute has been working with Vietnam's research institutes to developed AWD suitability maps for Vietnam. This work is based on the climatic suitability analysis method described by Nelson et al. (2015) and Sander et al. (2017) and has been expanded by an adoption capacity analysis (section 5.2).

The climatic suitability maps (Figure 1) show that, for the first two cropping seasons: January-April Harvest (JAH),equivalent to the winter-spring season the MRD and May-August Harvest (MAH), equivalent to the summer-autumn season the and the spring seasons in northern Vietnam, most of the planted rice lands of the country are climatically suitable for AWD. The lowly suitable lands are mainly found in the September-December Harvest (SDH), equivalent to the autumn-winter season in MRD and the summer season in northern Vietnam.

Nearly 2 million ha of rice land in South Central Coast (SSC), South East (SOE) and Mekong River Delta (MRD) are climatically suitable for AWD in the first rice season of the year. This area together with climatically suitable land in the two other rice seasons indicates a high AWD scaling potential of more than 4 million ha annually (Table 1).

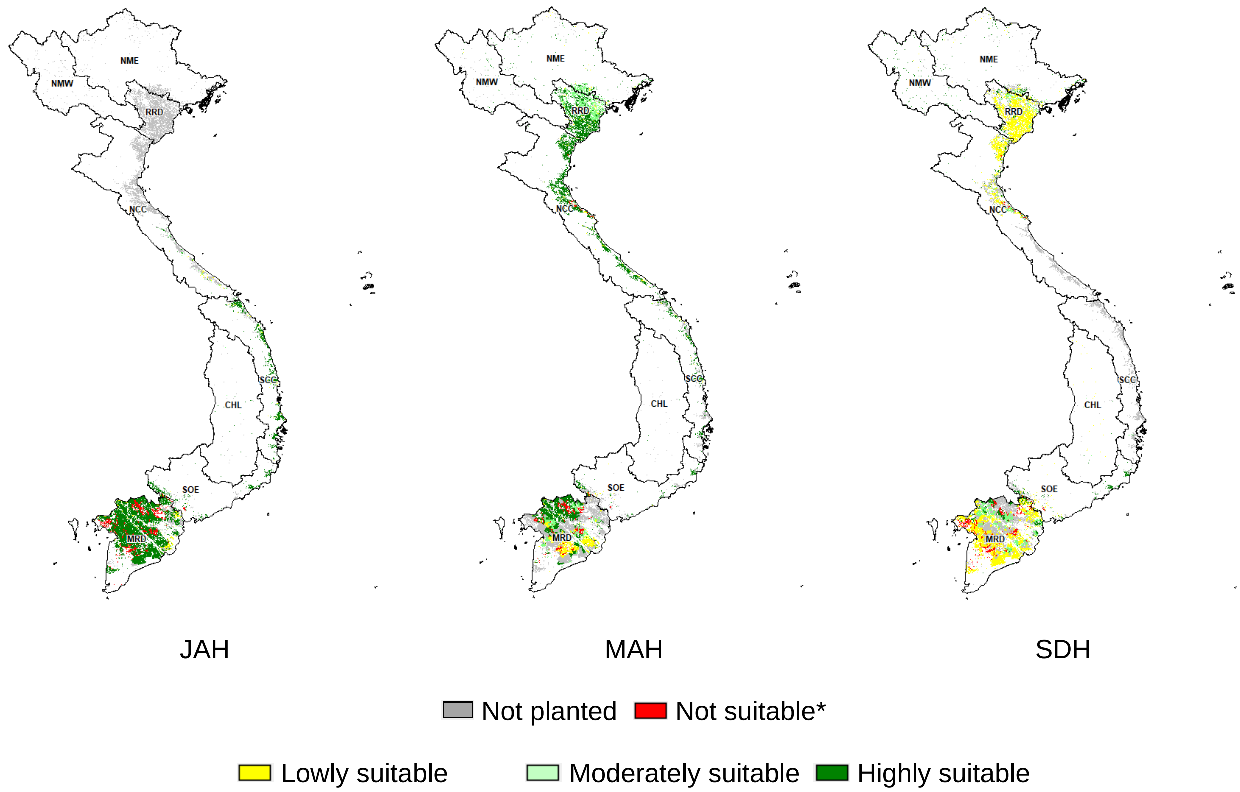

Figure 1. Maps of AWD suitability by ecological region in three cropping seasons (JAH= January-April harvest; MAH = May-August harvest and SDH = September-December harvest).

Table 1. Upper ceiling of climatically suitable area for WSTs by copping season*

Water saving practice	Potential area for water saving practices (1000 ha)			
	JAH	MAH	SDH	Annual
AWD (or MSD)	1,991.85	1,809.33	339.82	4,141
MSD	30.2	479.89	380.79	890.88

*** NOTE**: Suitable area will be reduced depending on local adoption capacity (see section 5.2)

3. AWD implementation scenarios

This report presents an analysis of the three AWD scaling scenarios based on NDC implementation plans proposed by the Ministry of Natural Resources and Environment (MoNRE) and the Ministry of Agriculture and Rural Development (MARD). The Scenario 1 and Scenario 3 were identified in Vietnam's NDC implementation plan (MoNRE, 2015) with and without international support, respectively. The Scenario 2, a revised version of Scenario 1, was later issued by MARD (MARD, 2016). Because Vietnam's NDC document is still being updated, this analysis takes all three scenarios into account.

For the Scenario 1, AWD could be applied on 1.5 million ha of rice land in RRD and MRD, where irrigation infrastructure is well developed to ensure availability of irrigation water during the whole cropping season. In the RRD, practicing AWD is only climatically suitable in MAH (spring rice). In MRD, AWD can be applied in both, JAH (winter-spring rice) and MAH (summer-autumn rice). The national targets for the Scenario 2 and 3 are 500,000 ha and 250,000ha respectively. However, all the suggested **scaling scenarios depend largely on the baseline**, most importantly of the current status of uptake of AWD and MSD. A detailed discussion of the scaling strategy will be important.

4. GHG reduction potential of AWD scaling scenarios

Estimation of GHG emissions of the three scenarios above was conducted using the SECTOR tool (Wassmann et al., 2019), following the IPCC Tier 2 approach for rice (IPCC, 2019) with newly updated scaling factors. The estimation used different methane emission factors (kg CH4/ha/d) per cropping season in RRD and MRD (Table 3) according to Vo et al., 2020. Seasonal crop duration (days) and yield by region published by GSO (2017) were used as input parameters for GHG calculations.

As shown in Table 4, potential GHG reduction of the scenarios was calculated by comparing total emission under water-saving practices (AWD and MSD) and under conventional continuous flooding (CF) practice. Results shown in Table 4 indicate that GHG emissions can significantly be reduced from 23% to 37% if water-saving practices are applied.

Table 3. Methane Emission Factor (EF) by region and rice season*

Region	CH4 emission factor (kg CH_4/ha/day)		
	JAH	MAH	SDH
Red River Delta	-	2.213	3.894
Mekong River Delta	1.718	2.797	3.583

* Data source: Vo, T. B. T. et al. (2020)

Table 4. GHG reduction potential*

	GHG emission (Mt CO2e/year)								
	Scenario 1 (1.5 million ha)			Scenario 2 (500 thousand ha)			Scenario 3 (200 thousand ha)		
	CF	MSD	AWD	CF	MSD	AWD	CF	MSD	AWD
Emission	15.25	11.57	9.54	4.87	3.72	3.09	2.11	1.62	1.35
Reduction*	-	3.68	5.71	-	1.15	1.78	-	0.49	0.76

***NOTE:** Reduction potentials shown in this table are based on the assumption that current water management practice in all rice areas is continuous flooding with limited organic input.

5. Example of in-depth AWD suitability mapping and analysis

A detailed analysis for AWD suitability and scaling potentials was done for An Giang province. The analysis process includes the 3 following steps:

5.1. Soil and climatic suitability analysis

In this step, detailed soil and land use maps of An Giang at a scale of 1:50.000 were used to identify climatic suitability levels. The output of this step is climatic suitability maps showing seasonal suitable land for water-saving technologies (Figure 2).

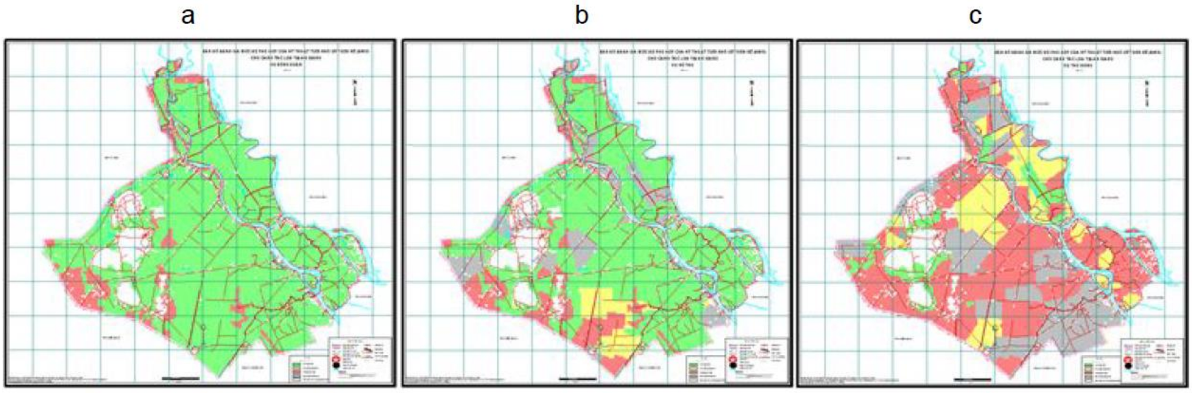

Figure 2. An Giang Province AWD climatic suitability maps for (a) winter-spring season, (b) summer-autumn season and (c) autumn-winter season. Green color represents high suitability, yellow is moderate suitability, red is low or no suitability, gray color means no rice is planted, and white color means other land-use types.

5.2. Adoption capacity analysis

Based on the climatic suitability maps, further analysis was done to evaluate factors that influence the adoption capacity for AWD.

For this analysis, factors and its influences were identified through discussions with key personnel from local agencies under the Department of Agriculture and Rural Development (DARD) and researchers from national research institutes. In the case of An Giang, five influencing factors were taken into evaluation, including (1) topography of the area, (2) irrigation infrastructure, (3) drainage capability, (4) farmer awareness of the technology, and (5) cooperative authority. A scoring method was used to rate these factors by local experts for each commune. The list of adoption factors and its ratings are shown in Table 5.

Table 5. Scoring factors for AWD adoption capacity

	Low capacity	**Moderate capacity**	**High capacity**
Topography	Flooded	Sloped	Flat
Canal infrastructure	<30% concrete	30%-50% concrete	>50% concrete
Drainage capability	Seasonally low drainage capability	Seasonally moderate drainage capability	Seasonally high drainage capability

(combination of flooding, rainfall, pumping stations)			
Farmer awareness	Unaware or unwilling to adapt	Some awareness but lack ability or motivation	Aware and willing to adapt
Cooperative authority	Low authority – farmers don't follow rules/ recommendations	Moderate authority - farmers rarely follow rules/recommendations	High authority - farmers follow rules/ recommendations

Each factor was scored on a scale from 1-10. Based on the final rating score, AWD adoption capacity maps were developed with 3 classes, i.e. high, moderate and low capacity (Figure 3). In total 22 DARD staff, two staff from each of the 11 districts in An Giang province scored each commune in their respective districts (for a total of 149 communes) according to the adoption capacity criteria.

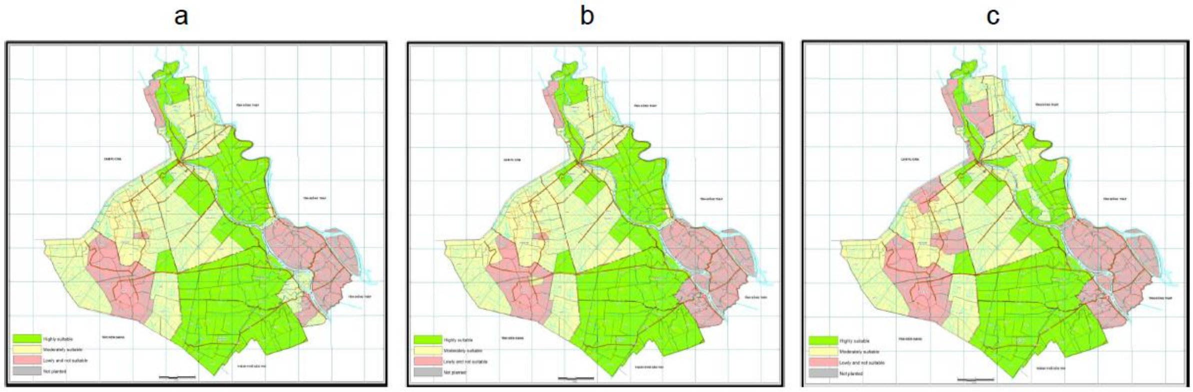

Figure 3. Adoption capacity maps for (a) winter-spring, (b) summer-autumn and (c) autumn-winter season of An Giang province. Green color represents high adoption capacity, yellow is or moderate capacity, red is low capacity.

5.3. Participatory verification of overall AWD suitability maps

In the last step, the overall AWD suitability maps were verified through a participatory feedback process conducted at An Giang province with participation of provincial and district officials of DARD. In this process, local officials were asked to review suitability levels for each of the three seasons. Updates of improved infrastructure, recent land-use changes, water saving practices applied in last seasons and other local knowledge were used to verify suitability levels. In general, suitability levels in most of the rice land of the province were accepted by participants. Suitability levels in some areas were adjusted with consultation of local officials.

The AWD suitability maps were then finalized after feedback from local stakeholders. Figure 4 shows the final verified AWD suitability maps for three rice seasons of An Giang province. The AWD suitability maps were officially transferred to An Giang DARD with appearance of representatives of DCP and 8 provinces of the MRD.

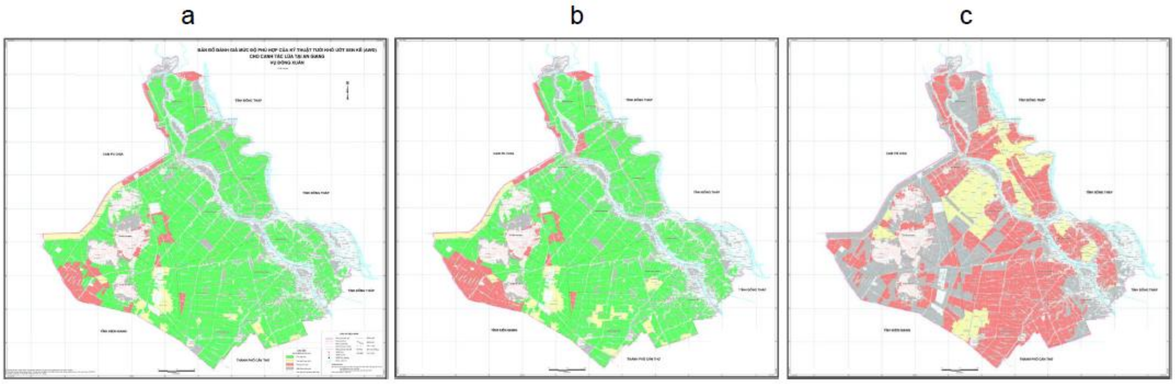

Figure 4. Overall AWD suitability maps for (a) winter-spring, (b) summer-autumn and (c) autumn-winter season of An Giang province. Green color represents high suitability, yellow is moderate suitability, red is low suitability, gray color means no rice is planted, and white color means other land-use type.

To date these maps are the best reference to support AWD implementation plans. The process can be applied to other provinces of Vietnam, as well as in other countries, to put the NDC commitments into action at the regional and local level. At meso- and macro levels, the AWD suitability analysis method together with GHG measurements can be applied to assess the potential for regional and national GHG mitigation in the rice sector.

6. Next steps/ recommendations

1) It will be crucial for IRRI to understand the baseline assumptions (baseline year and, thus, assumed area under WSTs) to conduct the final analysis of scaling- and reduction potential.

2) It will be important to understand details of MARD’s outscaling strategy, e.g. working with a small number of provinces in depth or working with a larger number of provinces on smaller shares of rice land.

3) The analysis of the adoption capacity may reduce the suitable area as compared to the climatic suitability analysis. This analysis can be conducted during the implementation phase but the initial plan should, thus, aim for a larger area for implementation of WSTs.

4) The analysis of GHG emissions and the GHG reduction potential can be improved with more details of current management practices in each season in the various provinces (e.g. straw and manure management, cropping system, fertilizer inputs, etc.).

7. References

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