ATLAS USE CASE: CLIMATE-RESILIENT CROP PLANNING

Cambodia Mekong Delta Digital Atlas - CAM-MeDiA

1. Crop planning in the context of climate change

Much of Cambodia's agricultural productivity is constrained by dependence on rainfall. Some 80% of total national rice production is derived from the wet season rice crop (FAO 2016). Rain-fed rice is the dominant crop cultivated in the Cambodian Mekong Delta, and other crops which are grown to a lesser extent include cassava, maize, sugar cane and soybeans.

Rice cultivation and the livelihoods of farmers are threatened by both drought and flood, with the latter especially damaging during the end of the wet season. Drought poses a critical hazard to the agricultural sector. The FAO describes the economic consequences of drought in rebuilding livelihoods and protecting lives in Cambodia as substantial (Inter Press Service 2016). Studies indicate future climate change will lead to intensified agricultural drought and flooding in the southern part of the Mekong Basin (Evers & Pathirana 2018). By the 2030s across the Mekong basin, average temperature is projected to increase by 0.79°C and precipitation to increase by up to 13.5% which will be mostly evident during the wet season (MRC 2010).

Climate change can influence rice yields though changes in temperature and precipitation. Rice yield is reduced to zero when soil saturation falls below 30% (ICEM 2013a). Increased temperature has been associated with reduced rice production in a variety of studies (Welch et al. 2010; Luo 2011; ICEM 2013a; Stuecker et al. 2018; IRRI 2020). Increased temperature during the dry season can especially threaten production (ICEM 2013a).

In addition to climate, a range of factors can influence rice productivity, including rice varieties grown, soil characteristics, and cropping patterns (ICEM 2013a). Past studies have proved somewhat inconsistent with regard to the impact of climate change on rice productivity in the Mekong Delta, which have been attributed to a variety of factors including the different climate models and scenarios, and crop productivity models used in the studies (ICEM 2013a).

Hydropower development, including that proposed for the mainstream of the Mekong River, poses another critical threat to agricultural and fisheries productivity (Yoshida et al. 2020). Climate change, including increased temperature and altered precipitation regimes (ICEM 2013b), are likely to exacerbate impacts on fisheries caused by hydrological changes from hydropower development (Evers & Pathirana 2018).

The digital Atlas seeks to improve understanding of the potential consequences of future climate change on infrastructure assets, agriculture and natural ecosystems of the Cambodia Mekong Delta.

The **Ministry of Agriculture, Forestry and Fisheries (MAFF)** is responsible for agricultural planning and development. MAFF contributes to land use policies and natural resources management, and is tasked with monitoring agricultural development activities. The Ministry is responsible for providing guidance on the optimal use of agricultural land to improve productivity, including selection of crops, livestock, and soil quality.

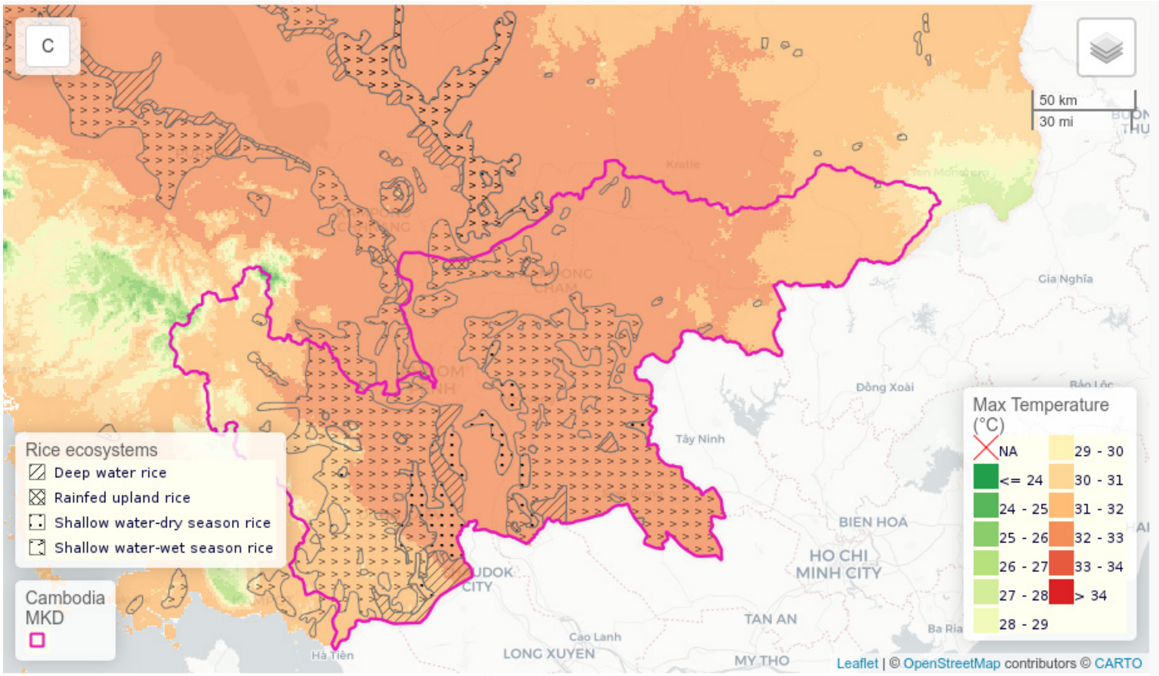
The **Cambodia Mekong Delta Digital Atlas (CAM-MeDiA)** provides insight into potential future changes of temperature, precipitation, flood, and drought across the delta. Regarding changes to temperature and precipitation, the Atlas incorporates three global climate models (GCMs)[i]; and displays outputs from three scenarios (RCP 4.5, 6.0 and 8.5)[ii] for both the dry and wet seasons, and annually. CAM-MeDiA enables users to overlay crop patterns, and land use/land cover features on future projected climate change variables (changes of mean maximum temperature and percentage changes in mean precipitation), and projections of future drought and flood.

Drought is projected to be variable across the Delta in the 2050s though noticeably prolonged by up to one month in the central region, and also in the western and eastern fringes. Increasing flood depths of up to 3+ m for much of the central region is projected in the 2060s. By the 2060s, during the dry season under RCP 8.5, much of the region will experience temperature rises of ~2°C. Such projected changes will have important consequences for future crop and fisheries productivity, and the livelihoods of farming and fishing communities.

2. CAM-MEDIA maps

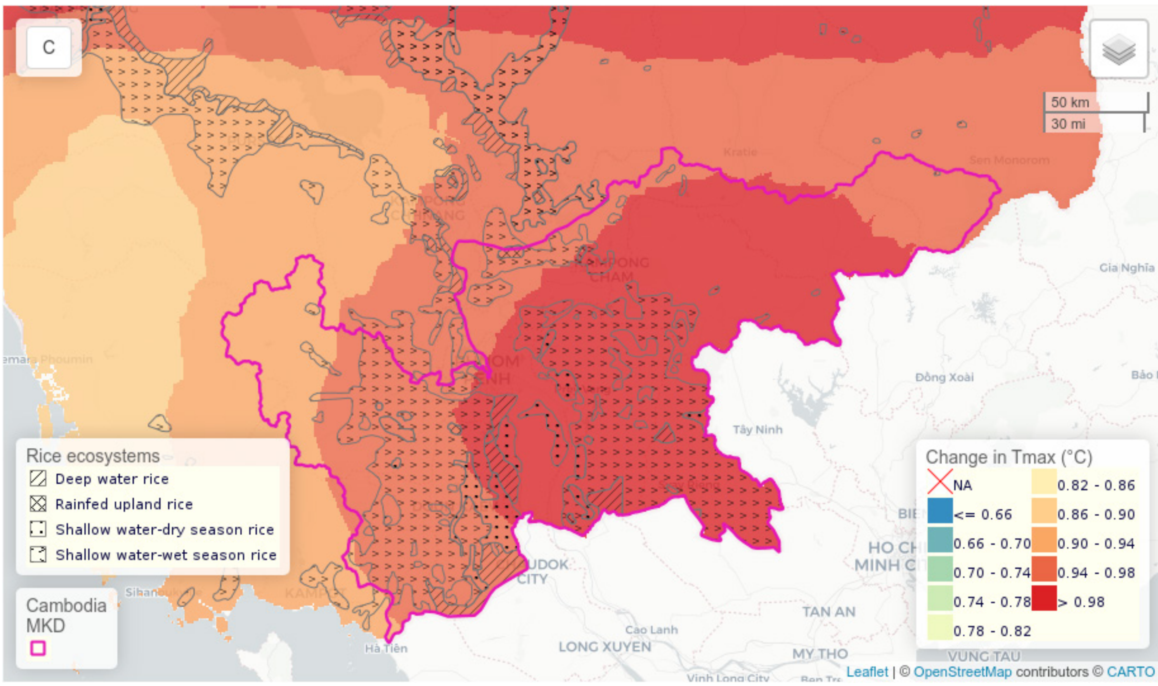
Overlaying of the current crop patterns/land uses on future projected scenarios of temperature, precipitation, drought and flood can indicate whether alternative climate-resilient cropping options need to be considered, such as the adoption of more drought or flood tolerant varieties of rice, shifting to non-rice crops, alternative land uses, and/or investment in irrigation infrastructure. Such changes might require consideration of existing or planned infrastructure, such as irrigation canals, sluice gates, embankments, reservoirs; to changes in land use and land cover within the drainage basin. Note that projected changes in temperature and precipitation (2030s and 2060s) are in comparison to the baseline period of 1961-1990.

Rice ecosystems (2013) overlain on projected average Tmax in 2030s (RCP 8.5, wet season, 2030s, GCM: IPSL-CM5A-MR).



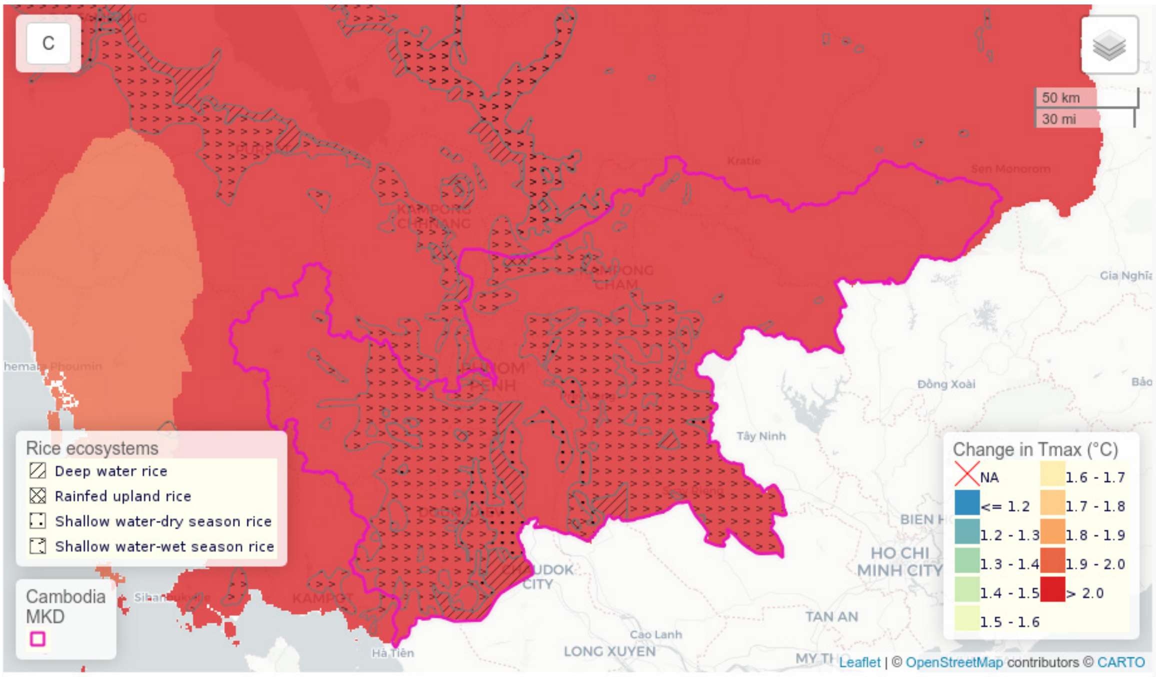
Average maximum temperatures of 32-33°C over much of the Cambodian Mekong Delta are projected for the 2030s. Projected temperatures are derived in this example from RCP8.5 – the highest emissions scenario – and represent the upper end of plausible projected temperatures. This projection is for the **wet season** and enables users to identify which areas of shallow water wet season rice cultivation are likely to experience highest temperatures and thus potentially where yield may be reduced.

Rice ecosystems (2013) overlain on projected changes in average Tmax in 2030s (RCP 8.5, wet season, 2030s, GCM: IPSL-CM5A-MR).



Projected increases in maximum temperature in the 2030s during the **wet season** are overlain by shallow water wet season rice. Temperature increases could potentially result in lower rice yields. Future adaptation options might include selecting different rice varieties and/or diversifying crops.

Rice ecosystems (2013) overlain on projected changes in average Tmax in 2060s (RCP 8.5, wet season, 2060s, GCM: IPSL-CM5A-MR).

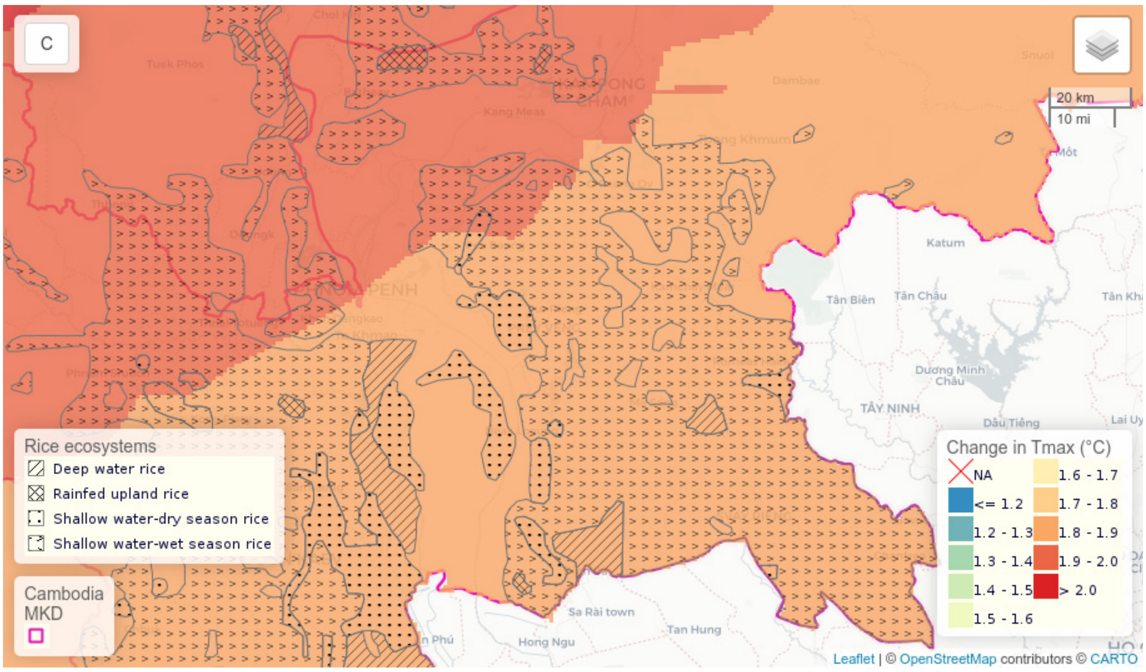


What would be the consequence of a 2°C temperature rise on shallow water wet rice productivity? Adaptation options might include selecting more heat resistant rice varieties, diversifying crops, or shifting the planting season to after the hottest period of April/May.

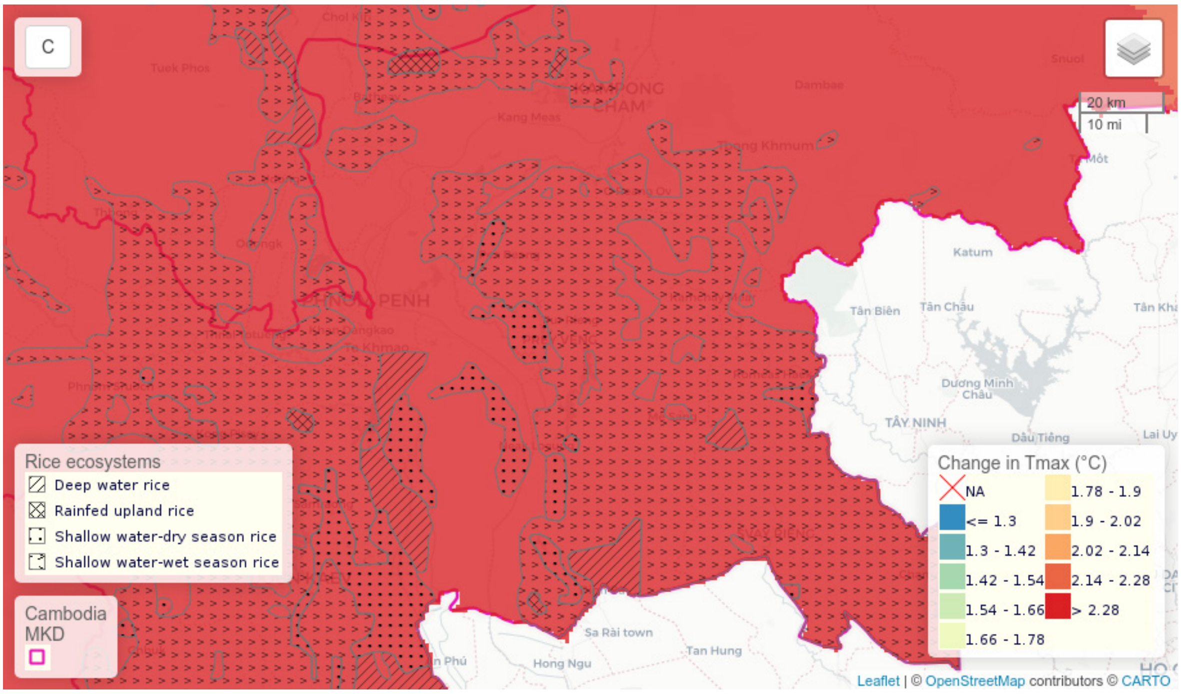
Note that the above displays only one RCP scenario from one GCM - users should also consider other RCPs (4.5 and 6.0) and the two other GCM models to ensure the full range of future projected climate variability is explored.

For comparison, projected changes in temperature under RCP 8.5 for the 2060s are shown in the following images for GFDL-CM3 and GISS-E2-R-CC.

Rice ecosystems (2013) overlain on changes in average Tmax in 2060s (RCP 8.5, wet season, 2060s, GCM: GFDL-CM3).

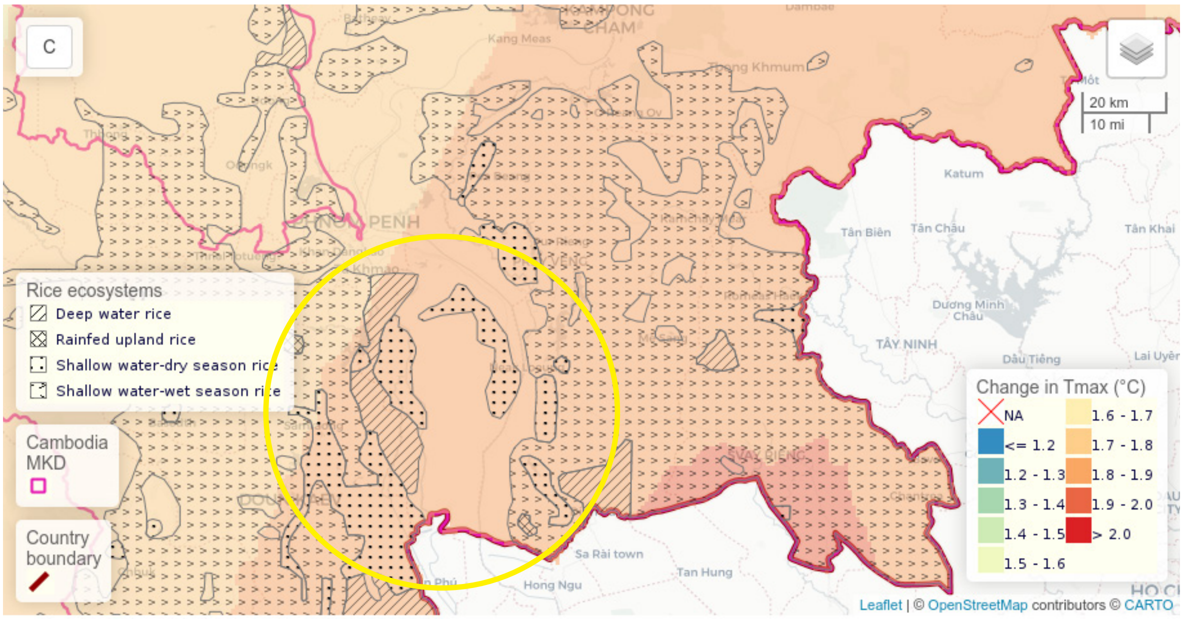


Rice ecosystems (2013) overlain on changes in average Tmax in 2060s (RCP 8.5, wet season, 2060s, GCM GISS-E2-R-CC).



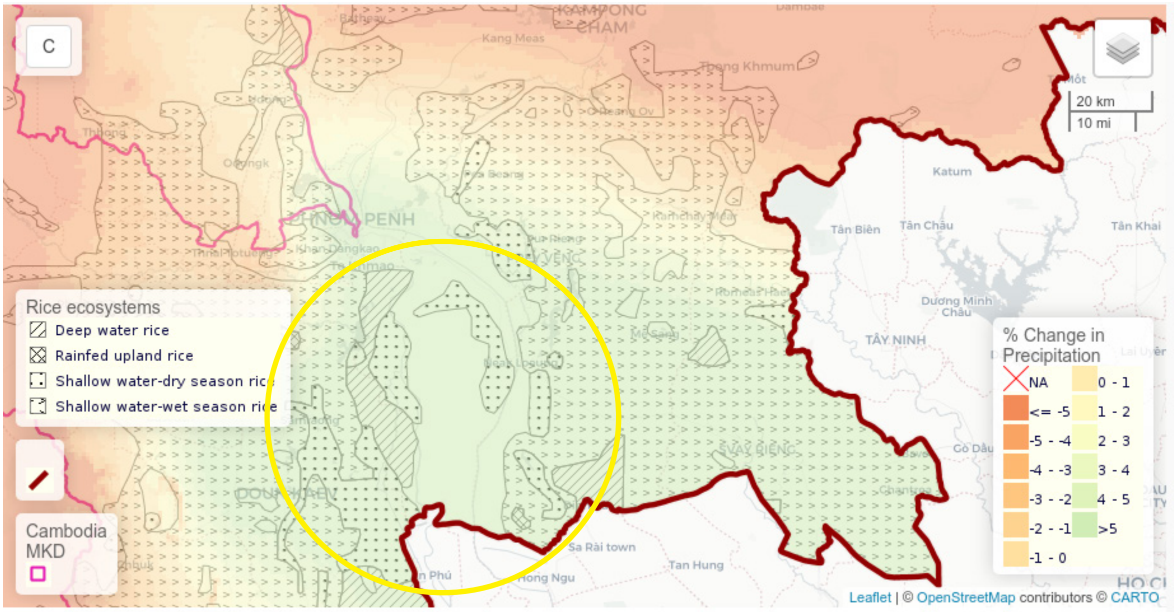
All three GCMs show projected temperature rises in the 2060s. The GCMs - GISS-E2-R-CC and IPSL-CM5A-MR – both project slightly higher temperature changes for the central region of the Cambodian Mekong Delta region compared to GFDL-CM3.

Rice ecosystems (2013) overlain on changes in Tmax in 2060s (RCP 8.5, dry season, 2060s, GCM: IPSL-CM5A-MR).



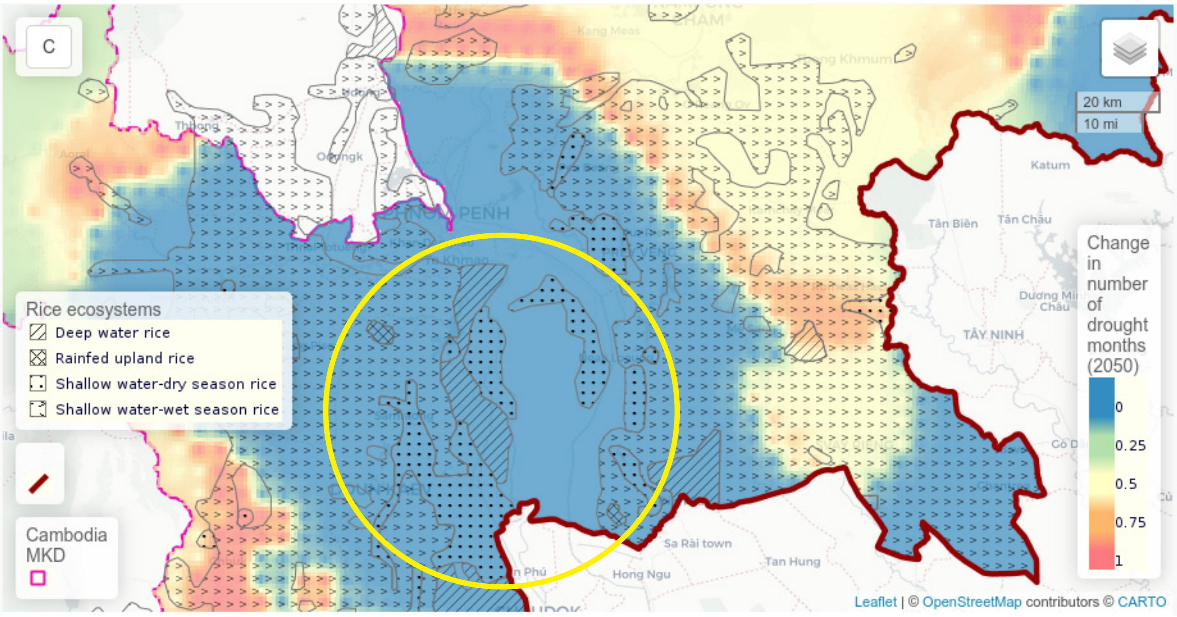
What are the impacts of a ~1.7-1.8°C rise on shallow water dry season rice cultivation (delineated by yellow circle)? To address likely reduced crop productivity, adaptation options may include growing more heat resistant varieties of rice, or diversifying crops.

Rice ecosystems (2013) overlain on changes in precipitation in 2060s (RCP 8.5, dry season, 2060s, GCM: IPSL-CM5A-MR).



An increase in precipitation pf ~5% is projected over the dry season where shallow water dry season rice is grown. This could prove beneficial given the projected increase in temperature.

Rice ecosystems (2013) overlain on changes in drought months in 2050s.



Though the drought projection in the 2050s is a decade earlier that the climate data projections in the 2060s (these data are from earlier projects), no prolongation of drought is projected for the 2050s. Based on projected increases in average Tmax and precipitation in the 2060s, and no change in projected drought duration in the 2050s, it would appear that increases in temperature would be the main concern for sustaining shallow water dry season rice productivity.

3. Bibliography

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[i] Global climate models (GCMs) are mathematical models used to generate future projections of climate change. Various research teams internationally have developed GCMs and these are used to examine the consequences of climate change. An evaluation of outputs from a selection of GCMs are required to determine the plausible range of projected climate variables such as maximum temperature and precipitation.

[ii] Representative Concentration Pathways (RCPs) represent different scenarios of future projected climate change or climate futures which are defined by different greenhouse gas concentrations. RCP 8.5 represents the highest emissions scenario (or worst case scenario), and RCP 4.5 is described as an intermediate scenario.

This fact sheet is the third in a series of use cases prepared by ICEM for the World Bank under the project titled Cambodia Mekong Delta Digital Atlas (CAM-MeDiA).