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RICE AREA AND PRODUCTION ESTIMATES FOR THE 2021 POST-MONSOON SEASON

Myanmar Agricultural Crop Yield Estimation Project

September 2022

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Submitted to
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DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the U.S. Agency for International Development, the U.S. Government, the Myanmar Ministry of Transportation and Communication, nor the Myanmar Government.

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MAIN FINDINGS

Burma rice production is currently a major source of concern due to political unrest and high inflation rates. Rice cultivation has generally been favorable during rainy seasons, accounting for about 83 percent of the total yearly production. Post-monsoon (summer) season rice accounts for the remainder and is often grown using high-yield varieties, irrigation, and fertilizer. This report presents an analysis of the vegetation and climatic conditions and provides area and production estimates (including uncertainties) for the eight main rice-producing areas in Burma. Machine learning and high-resolution satellite imagery interpretation were applied to estimate the rice area for the different regions. These data were combined with yield information to estimate total post-monsoon rice production.

The main findings that this report presents are:

- 2021 post-monsoon (or 2022 summer) rice-producing areas in Bago, Mon, Shan, and Yangon are in the same range as historical data.
- There was a decline in the 2021 post-monsoon rice-producing area for Ayeyarwady, Magway, Mandalay, and Sagaing.
- The largest decline in production area was in Ayeyarwady, with an estimated 30–40 percent decline from the previous year. Fields were barren and not cultivated with other crops, leading to a lower yield.
- The summer rice area in Mandalay and Sagaing has been variable due to ongoing conflicts starting in 2021, with a low 2021 post-monsoon area cultivated.
- The 2022 yields estimated by the International Food Policy Research Institute (IFPRI) study were lower than usual due to a lack of agricultural inputs, resulting in a decline in production for all regions.
- The highest decline in production area was found for Ayeyarwady, followed by Sagaing, Mandalay, and Magway.

An overall decline of 25–40 percent in the 2021 production of post-monsoon rice compared to historical values is estimated at the national level, due to (1) both substantially lower areas planted in rice, with fields often left barren and with lower plantings in areas both with high and relatively low levels of conflict, and (2) a drop in yields due to limited access to more-expensive inputs.

INTRODUCTION

Burma (Myanmar) rice production is currently a major source of concern due to COVID-19-related impacts, political unrest, and high inflation rates. These factors have directly impacted cash flow in supply chains, with agricultural firms facing cash flow shortages and diminished access to credit, creating greater vulnerability to economic crises. Another concern is the higher number of customers asking to purchase using credit, particularly in the Shan and Rakhine states and the Yangon region. Overall, COVID-19 and political problems due to the military takeover have severely affected the agri-food sector of Burma, raising doubts about the performance of the agricultural sector overall and the rice sector in particular.

Analysis shows that the 2021 monsoon-season rice production was generally in line with previous years. Weather conditions were generally favorable, and farmers were able to plant, grow, and harvest crops with sufficient input. However, a worsening political climate made the cultivation of crops more difficult in the post-monsoon season, and soaring prices limited the use of agricultural inputs. This report analyzes the 2021 post-monsoon (or 2022 summer) rice cultivation for the regions of Ayeyarwady, Bago, Magway, Mandalay, Sagaing, and Yangon, as well as the states of Mon and Shan (Rakhine state was not included in the analysis as its rice cultivation was quite low). High-resolution satellite imagery from active and passive sensors was combined with a sampling approach to estimate major post-monsoon rice areas and their production. Post-monsoon rice is primarily dependent on irrigation, limiting cultivation to the delta and areas with sufficient access to water resources from reservoirs, rivers, and lakes.

To support monitoring the food security in Burma under the impact of COVID-19 and political conflicts, this report presents an analysis of the vegetation and climatic conditions and provides area and production estimates (including uncertainties) for the eight main rice-producing areas in Burma in 2022. The report contains:

- An analysis of climate and vegetation factors for the 2021 post-monsoon (2022 summer) season
- Area estimates (in hectares [ha]), including uncertainty levels, of rice cultivation for eight selected rice cultivating regions in Burma for the 2021 post-monsoon (summer) season
- Rice production estimates, with uncertainty levels, for the eight selected regions in Burma for the 2021 post-monsoon (2022 summer) season

a) POST-MONSOON (SUMMER) RICE SEASON IN BURMA

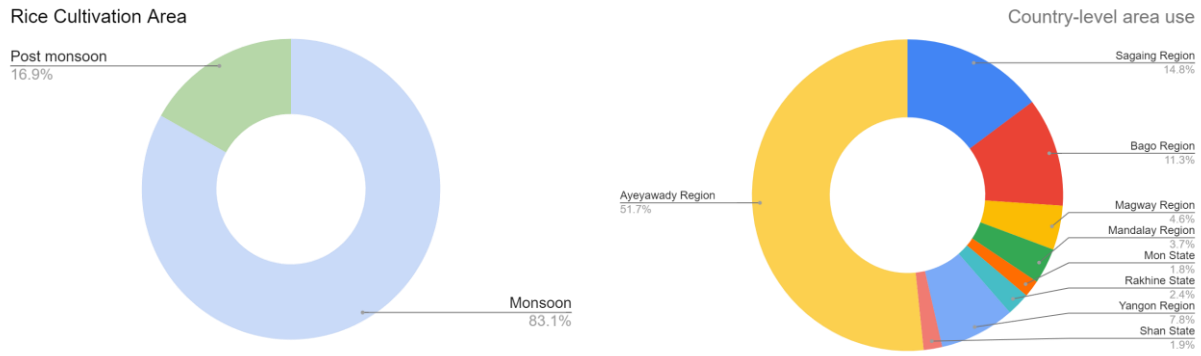


Figure 1. Distribution of post-monsoon vs. monsoon rice sown area in Burma (left) and the percentage of the post-monsoon area used by each region (right) (SCO, 2018).

Post-monsoon rice accounts for approximately 17 percent of the total rice cultivation area in Burma (Figure 1) and 23.4 percent of the total yearly production, according to the Central Statistical Office 2018 report (Figure 2). The larger production in relation to area is due to the generally higher yields achieved in summer. Post-monsoon rice is mainly distributed in eight regions and states in Burma: Ayeyarwady, Yangon, Bago, Mon, Mandalay, Sagaing, Magway, and Shan. The Ayeyarwady region constitutes 52.3 percent of post-monsoon rice production, followed by Sagaing at 14.1 percent and Bago at 12 percent (Figure 2).

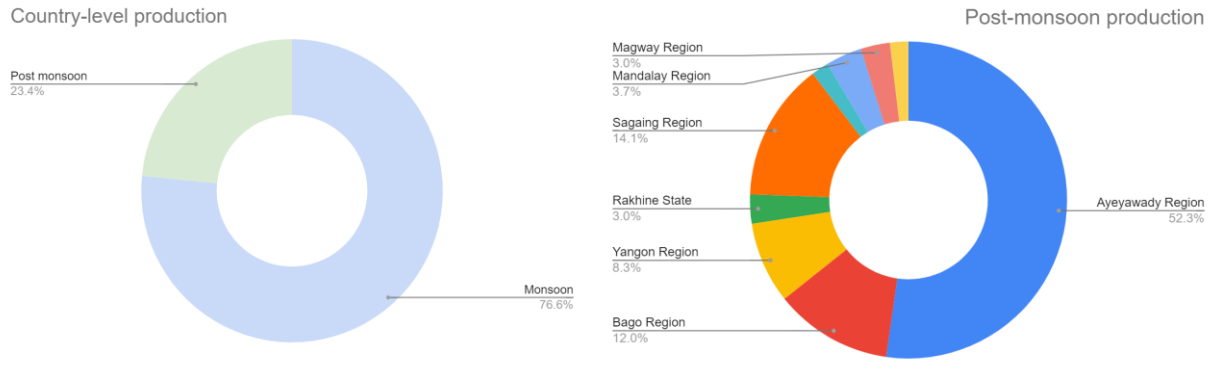


Figure 2. Distribution of total post-monsoon rice production in Burma (left) and by state and region (right).

Post-monsoon rice season in Burma is from late December to June; however, the cultivar calendar is flexible depending on water availability. In the lowland delta and coastal regions—including Ayeyarwady, Bago, Mon, and Yangon—rice cultivation starts between December and February. In the central dry zone and mountain upland regions, the planting starts later (from January to March). The harvest period depends on the planting date, taking place during the months of April to June (Table 1).

Table 1. Post-monsoon cultivar calendar by state and region.

Region	Planting	Harvesting	Focus Region
Delta lowland	December–February	April–May	Ayeyarwady, Bago, Yangon
Coastal zone	December–February	April–May	Mon, Rakhine
Central dry zone, mountain and upland regions	January–March	May–June	Magway, Mandalay, Sagaing, Shan

The post-monsoon cultivated rice area is mapped using a variety of satellite data, training data, machine learning, and information from the crop calendar. Satellite sensors include passive optical and active sensors using synthetic aperture radar. All satellite data are combined and sampled, after which a machine learning method helps detect rice fields from the images. This information contributes to a stratified sampling approach, after which high-resolution satellite data are used for point interpretation. Point interpretation helps achieve an unbiased area estimate, with confidence intervals for each state. In addition to the post-monsoon season, the same method of rice mapping was applied for estimating rice areas for the monsoon season of 2021. Additionally, a rainfall analysis was added for the river basins covering Burma using the Climate Hazards Group Infra-Red Precipitation with Station Data satellite-derived precipitation product. Vegetation cover was analyzed using a Moderate Resolution Imaging Spectroradiometer-derived (MOD13A1) satellite product on the enhanced vegetation index (EVI).

b) CLIMATE AND WATER RESOURCES

Rice in the post-monsoon season is mostly irrigated, making rainfall a less important factor for its production. However, monsoon rainfall should provide an adequate water supply to maintain rivers, lakes, and reservoirs. Figure 3 below shows the rainfall surplus or deficit at the basin level for the last three years. The boundaries of the river basins were included as rainfall in the catchment area determines overall water availability. Data from 1981 until now were used as a baseline. The figure shows that the 2021 rainfall conditions were quite similar to previous years, with higher amounts of precipitation in the south and below-average rainfall in the north. In general, 2021 rainfall conditions seemed favorable for 2022 post-monsoon rice production in all states and regions.

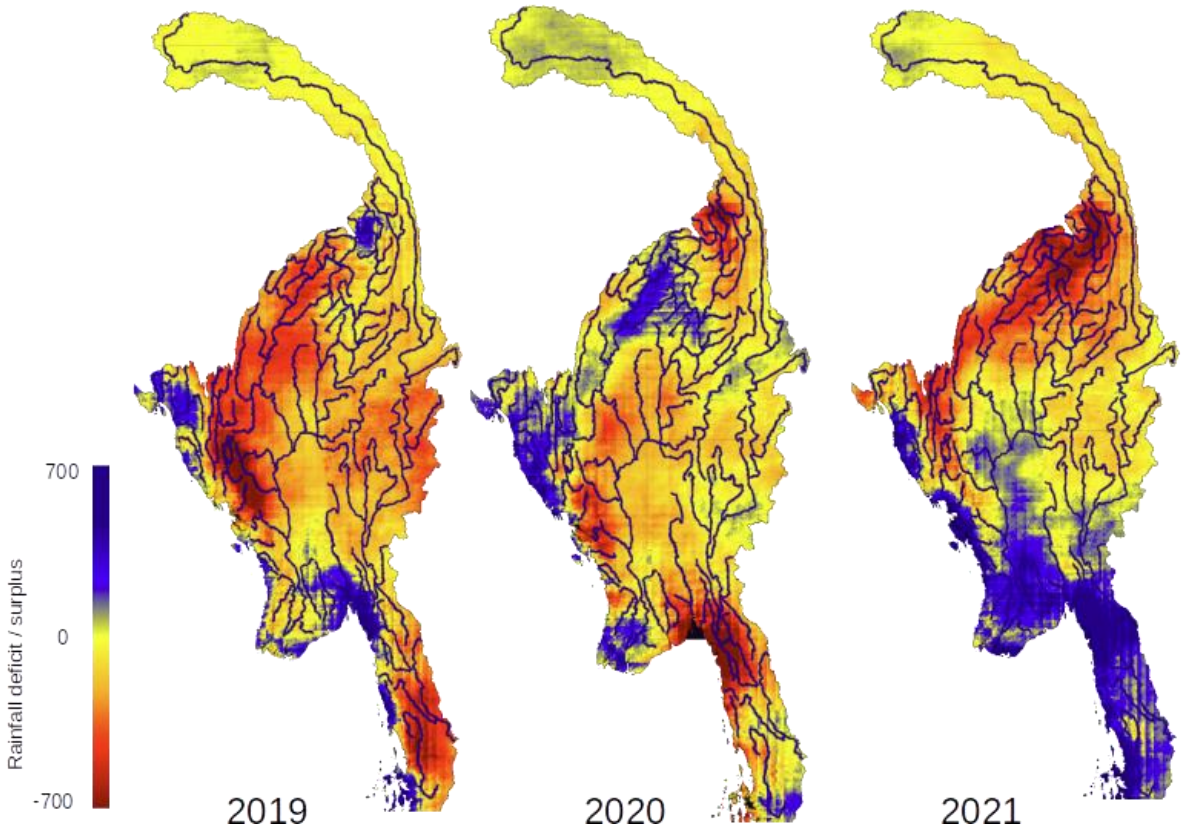


Figure 3. Burma rainfall anomaly for 2019–2021.

Rice cultivation in Sagaing, the second-largest producer of post-monsoon rice, depends on irrigation water from the Thaphanzeik reservoir. Water levels in the reservoir were reported to be low in 2021 but significantly improved in 2022 (Figure 4). Low water levels in 2021 were caused by the cumulative effects of historical rainfall patterns over the upstream area.

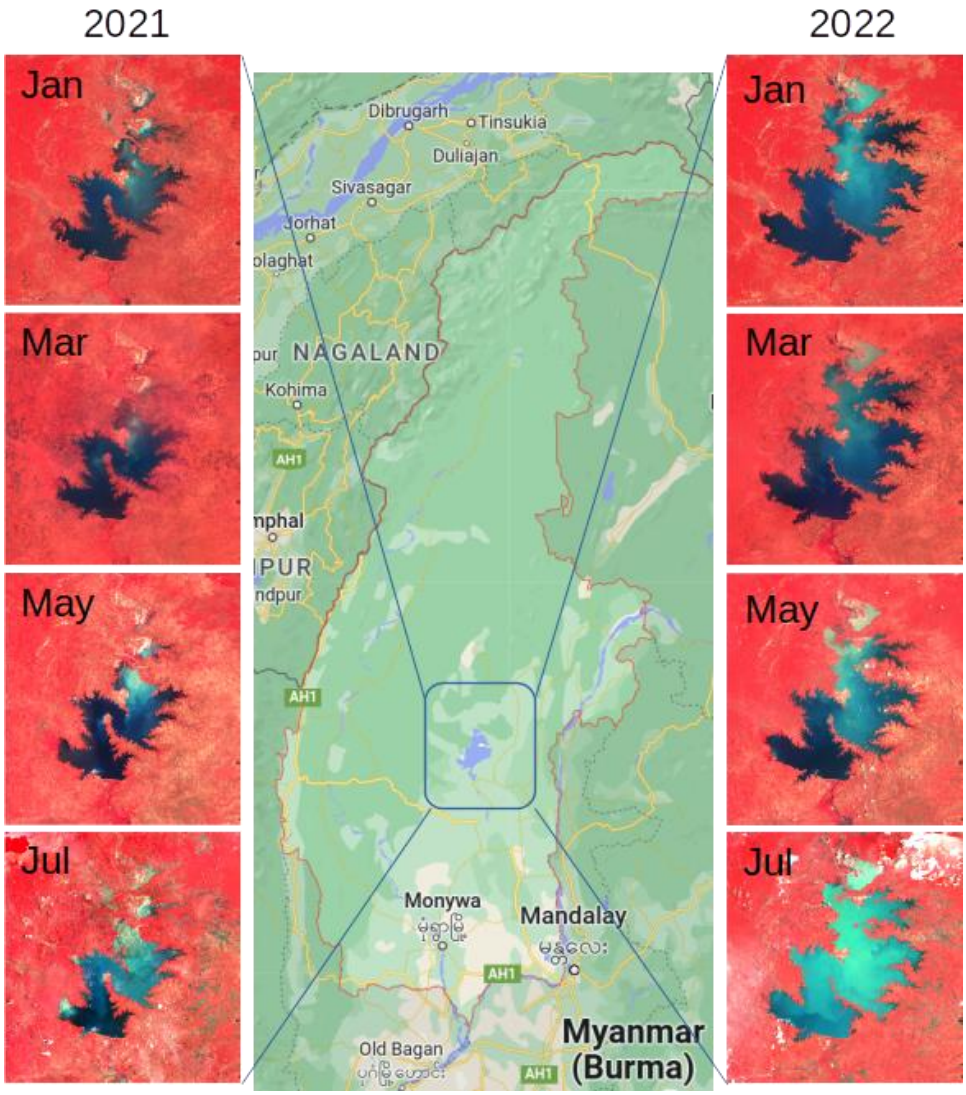


Figure 4. Satellite imagery of the Thaphanzeik reservoir water extent for January–July in 2021 (left) and 2022 (right).

c) FACTORS IMPACTING CULTIVATION IN THE POST-MONSOON RICE SEASON

The latest Myanmar Economic Monitor of the World Bank in July 2022 stated that Burma's economy faced a series of external and internal disruptions that have impeded recovery from the large contraction in economic activity in 2021. Gross domestic product in 2022 is estimated to be around 13 percent lower than in 2019, continuing to strain livelihoods and coping mechanisms severely. Poverty is estimated to have doubled since March 2020. With about 40 percent of the population living below the national poverty line in 2022, nearly a decade of progress on poverty reduction has been undone. Additionally, elevated levels of conflict in many areas of the country, specifically in Magway and Sagaing, continue to constrain the productive activity of all economic sectors, especially agricultural activities.

The IFPRI report that monitored the agri-food system in Burma stated in March 2022 that increased transport costs were driven by fuel price increases. These increases caused

difficulties in contracting transportation services. The report also states that farm prices for other crops like maize, pulses, and oilseeds increased between 32 and 78 percent due to export demand and the depreciation of the Burma kyat to provide incentives to farmers in the dry zone and mountainous areas. Paddy rice prices have increased by a lesser amount (23 percent)—not enough to offset increases in the cost of chemical fertilizer and mechanization services.

Increased prices for fertilizer and pesticides mean that many farmers are unable to afford agricultural chemicals. The decline in fertilizer sales appears to be especially severe in the delta region (IFPRI, 2022). A reduction in agricultural inputs has led to a reduction in rice yield, especially in the regions of Ayeyarwady, Bago, and Yangon.

Increased prices for agricultural inputs and transport lead to higher rice cultivation costs, which directly affect the rice cultivation situation and rice production in the post-monsoon season in Burma. This report includes the narrative of the impact of conflicts at township levels on rice cultivation practices in the Magway, Mandalay, and Sagaing regions.

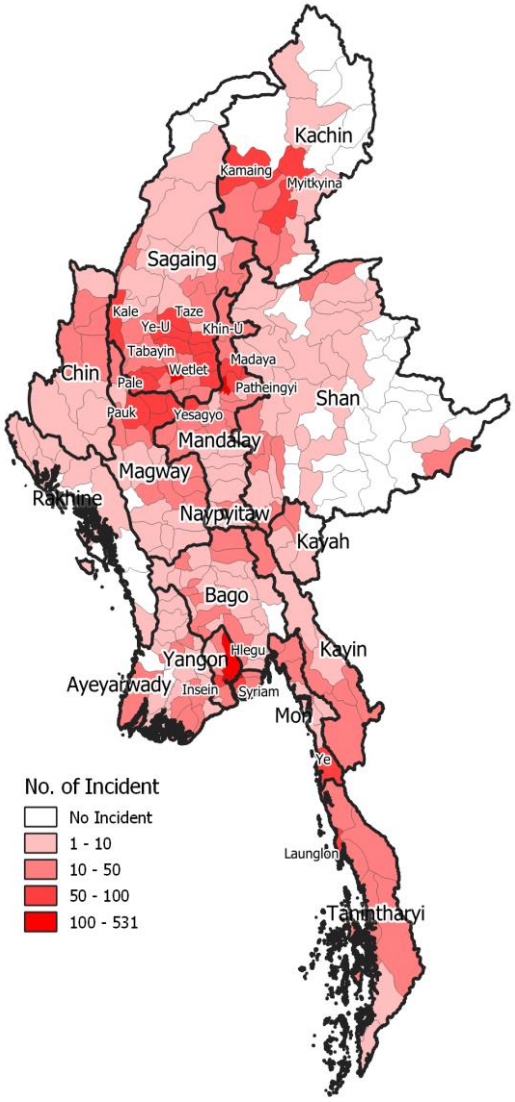


Figure 5. The number of violent incidents by township from January until September 2022 (Atalian-BM&A weekly report).

2. POST-MONSOON (SUMMER) RICE CULTIVATION AREA IN 2022

a) AYEYARWADY REGION

Figure 6 shows the post-monsoon rice area for Ayeyarwady. Green areas indicate cropland, and yellow areas indicate the locations where post-monsoon rice cultivation was observed in the satellite imagery. Ayeyarwady has the largest rice-growing area in Burma, accounting for over 50 percent of the total post-monsoon rice area. The figure shows that a larger portion of the total crop area is cultivated with post-monsoon rice compared to other states. Most rice cultivation concentrates around the central part of Ayeyarwady. However, the error-adjusted area estimate indicates a sharp decline in total crop area compared to previous years. For the 2021 post-monsoon season, the project team found a total error-adjusted area estimate of 349,841 ha, whereas data from the statistical yearbook and the General Administration Department (GAD) indicate historical areas between 471,000 and 617,000 ha in 2019 and 2020.

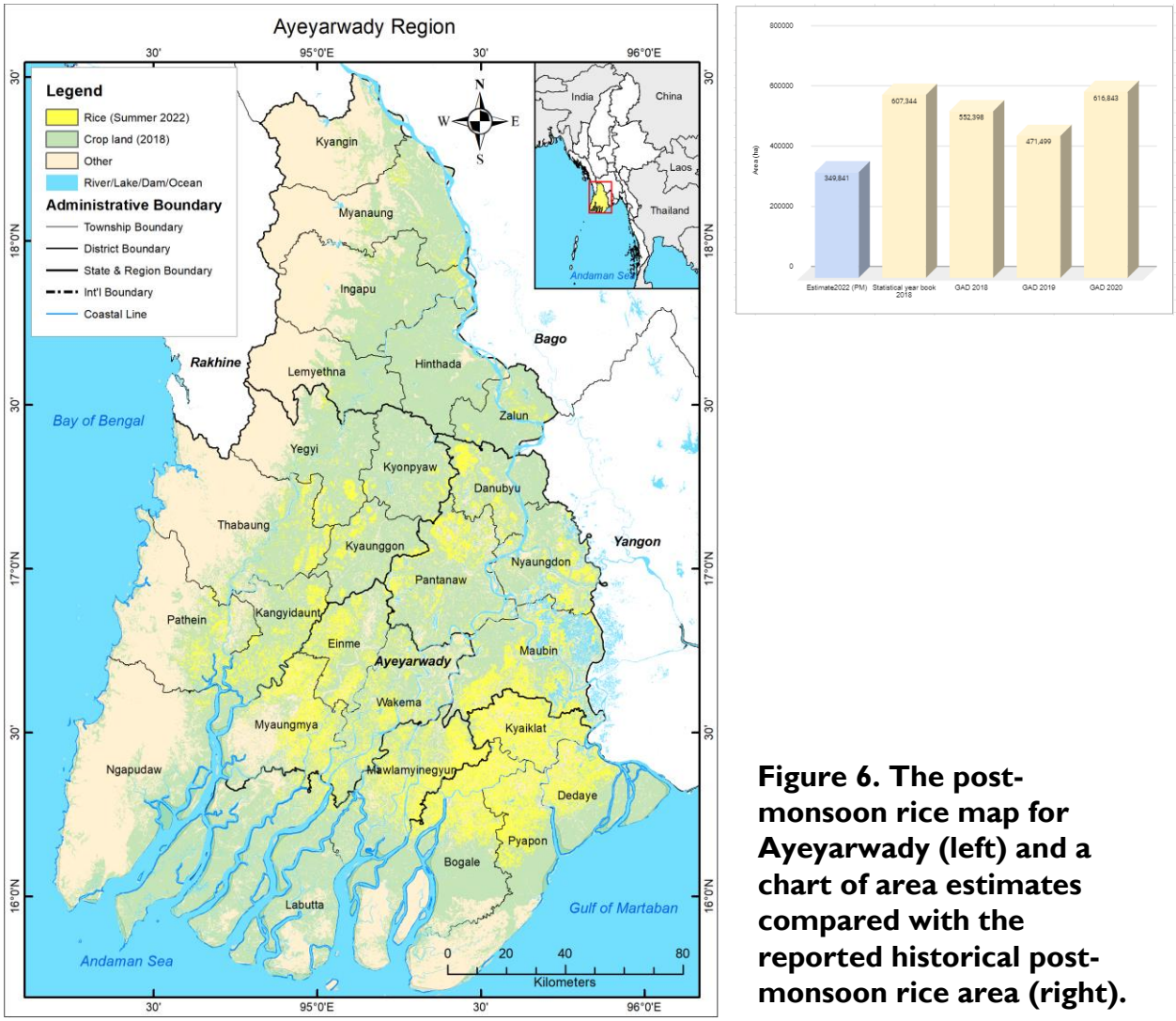


Figure 6. The post-monsoon rice map for Ayeyarwady (left) and a chart of area estimates compared with the reported historical post-monsoon rice area (right).

The post-monsoon rice cultivation area of 2022 was compared with the cultivated area in 2021 to determine whether the decline in the cultivated area was due to fields not being cultivated or their cultivation with other crops. Figure 7 shows the map with areas where rice was grown in 2021 but not in 2022. The colors represent the cumulative EVI anomaly. Negative anomalies (red) indicate that fields were left barren and nothing was grown in 2022, whereas yellow and green indicate that crops or vegetation were grown in 2022. The analysis shows that for most negative anomalies, no vegetation was grown in the 2021 post-monsoon period.

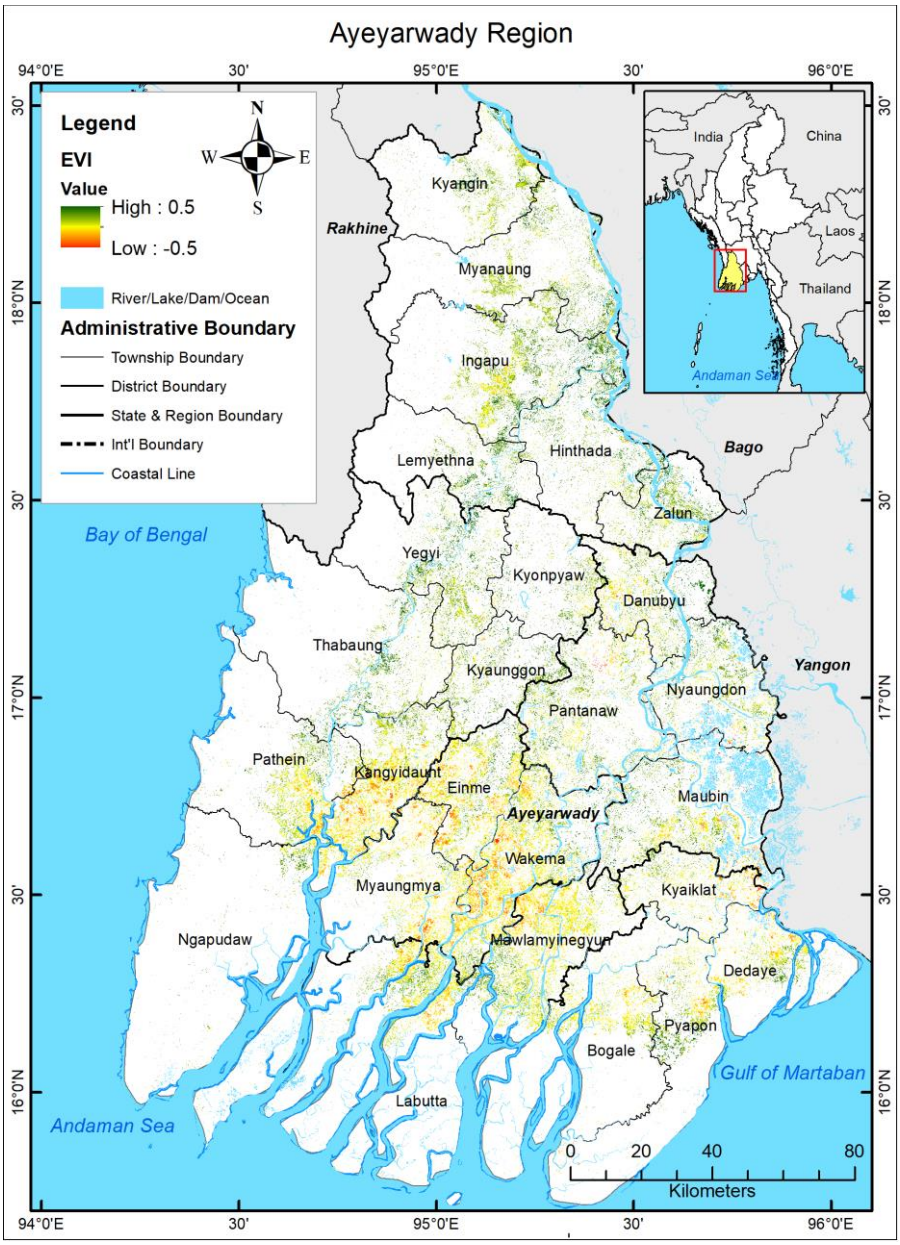


Figure 7. The cumulative anomaly for EVI in Ayeyarwady for areas where rice was grown in 2021 but not in 2022. Red indicates fields that were most likely left barren.

It is also possible to disaggregate the explicit spatial maps of rice cultivation areas at the township level for further analysis. Figure 8 shows the average reported rice cultivation area

by GAD during 2017–2020 and the 2021 and 2022 rice cultivation areas. In general, there is good agreement between the GAD data and the rice cultivation area derived from satellite imagery. However, townships such as Pyapon, Thabaung, and Wakema show a large decline in 2022 compared to the 2021 and GAD data. For most townships, the 2021 post-monsoon (summer) cultivated rice area was less than the historical data. Figure 9 shows examples of abandoned areas in these townships during the post-monsoon season of 2022 as a comparison of satellite images in February 2021 and February 2022.

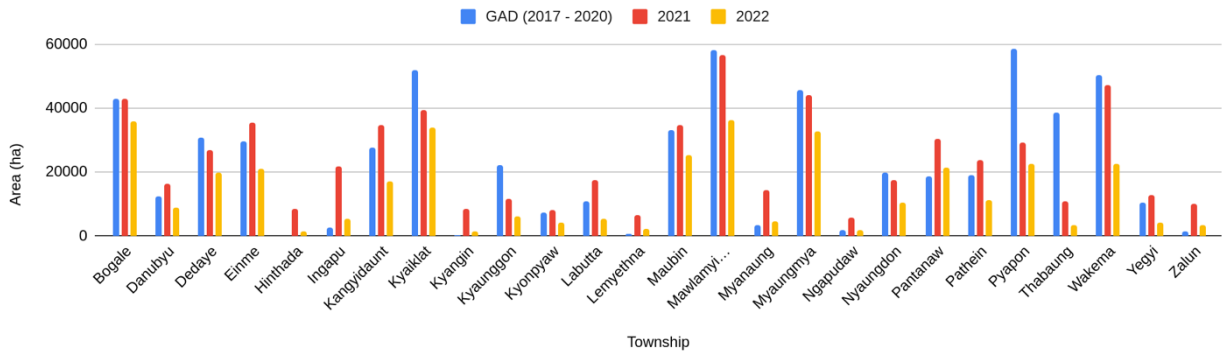
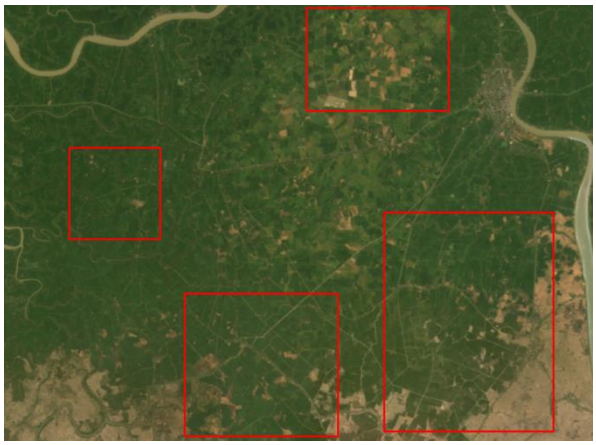
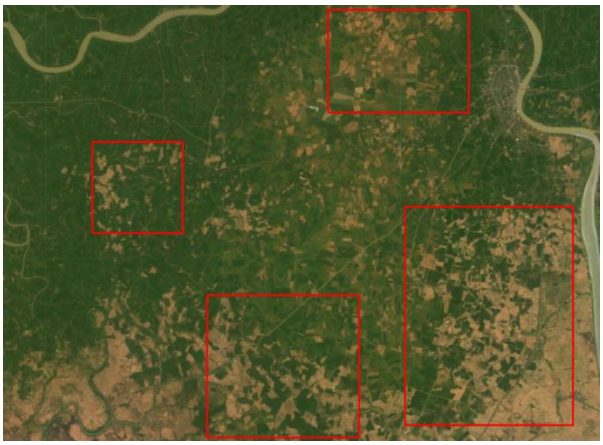


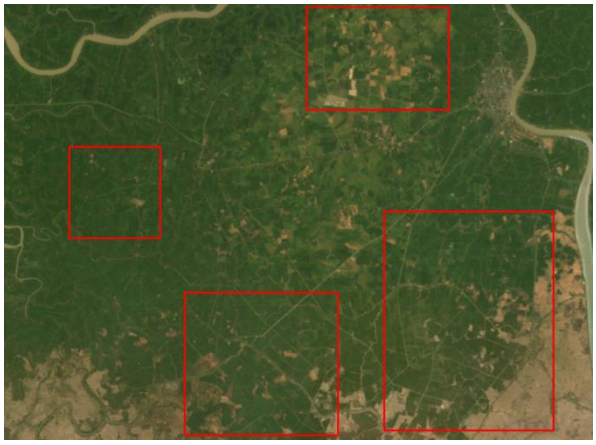
Figure 8. Cultivated area according to GAD (2017–2020) and satellite imagery (February 2021 and February 2022) for different townships in Ayeyarwady.



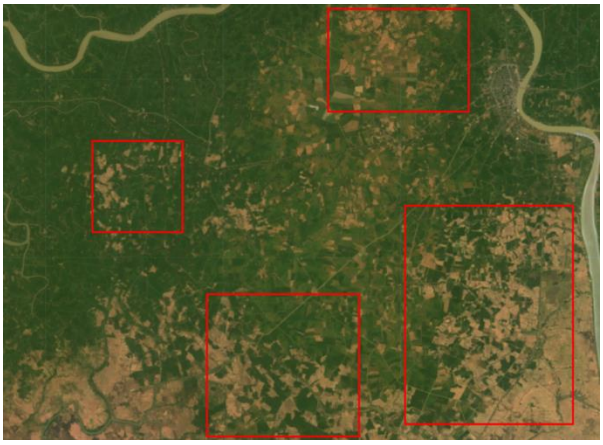
(Pyapon 2021)



(Pyapon 2022)

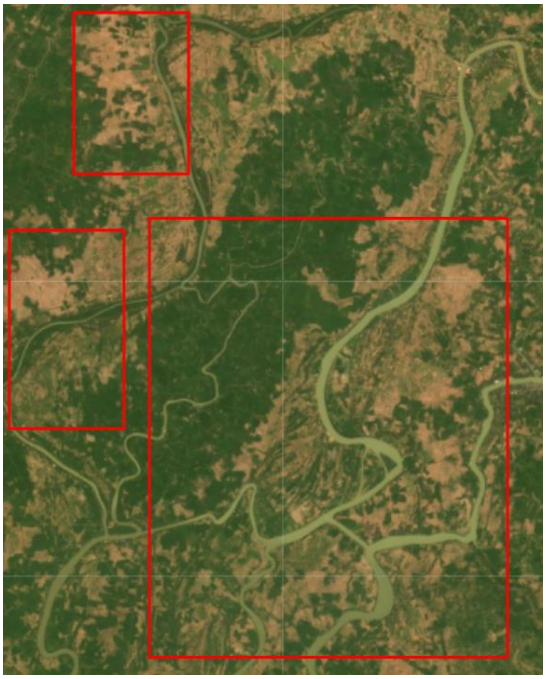


(Pyapon 2021)



(Pyapon 2022)

(Wakema 2021)



(Wakema 2022)

Figure 9. A comparison of rice planting areas in Pyapon (upper images) and Wakema (lower images) in February 2021 (left) and February 2022 (right) by Planet Image (green signifies land with vegetation cover, and light brown signifies barren land without vegetati

b) YANGON REGION

Figure 10 shows the post-monsoon rice cultivation area estimates for Yangon in 2022. In Yangon, the post-monsoon rice cultivation area is distributed across the region and forms a small fraction of the total crop area. The total error-adjusted area was calculated to be 81,422 ha, which is in line with the previously reported estimates from GAD and the statistical yearbook. Therefore, not much change in area cultivations has been identified in 2022.

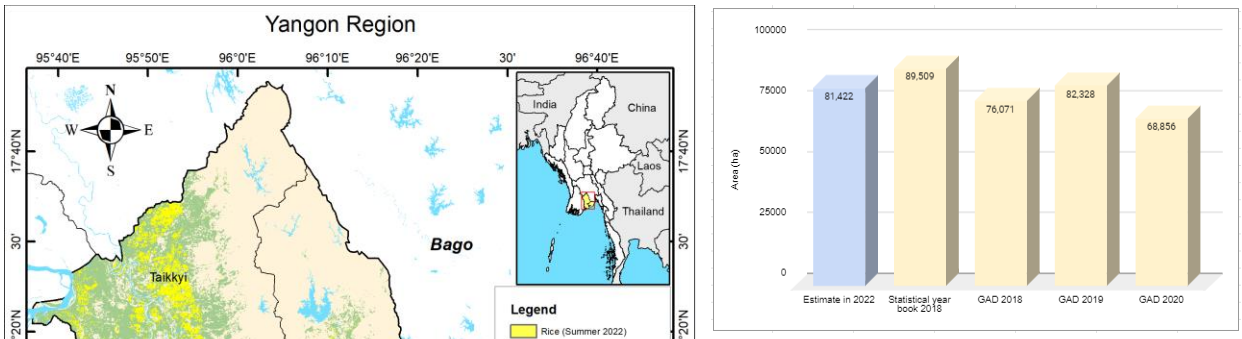
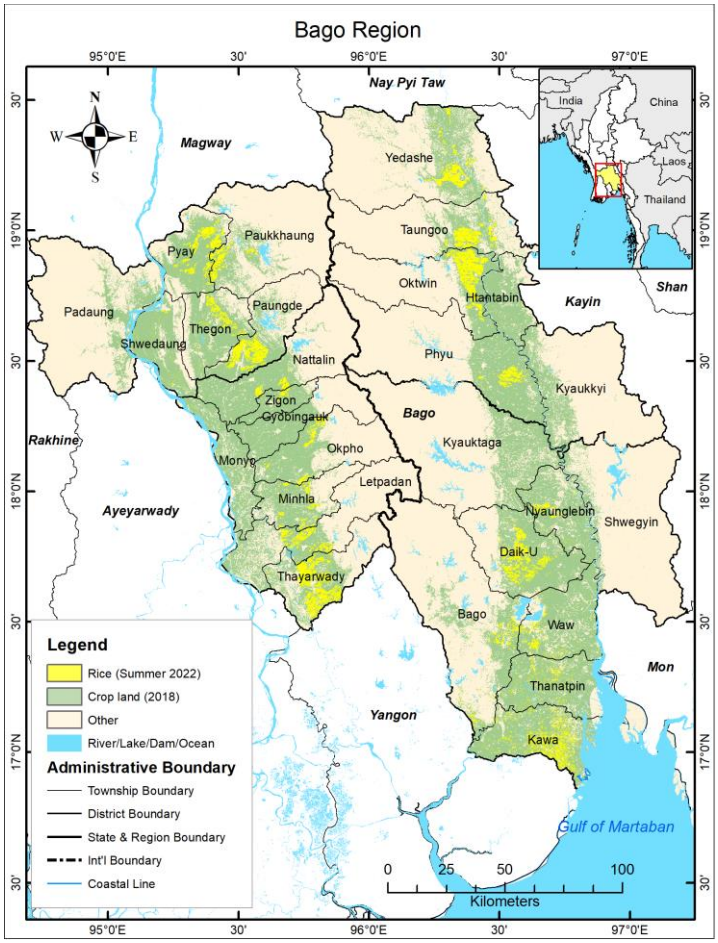


Figure 10. A rice map (left) and a chart of area estimates compared with reported historical rice areas (right) for Yangon region.

c) BAGO REGION

The post-monsoon rice area in Bago accounts for a relatively small fraction of the total crop area of the region but accounts for 11 percent of the total post-monsoon rice cultivation area in Burma. Figure 11 below shows that rice is grown in different townships throughout Bago. No sharp changes in the cultivated area were observed in the 2021 post-monsoon season. The historical GAD and National Statists data for Bago are in a similar range, with the lowest of 138,115 ha reported in 2020 and the highest of 169,061 ha reported in 2019. The project team estimated the total rice area of 152,683 ha for Bago in 2022.



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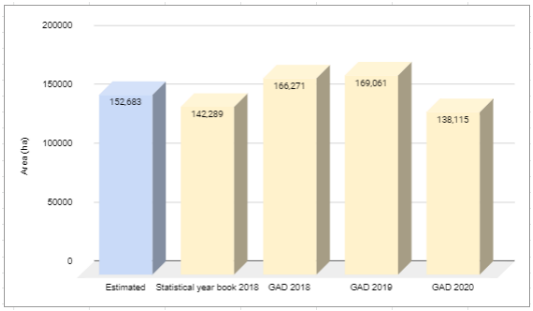

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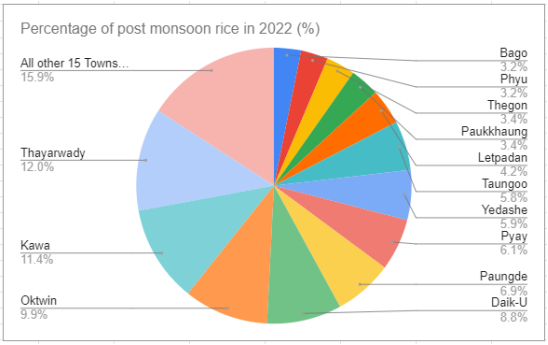


(C)

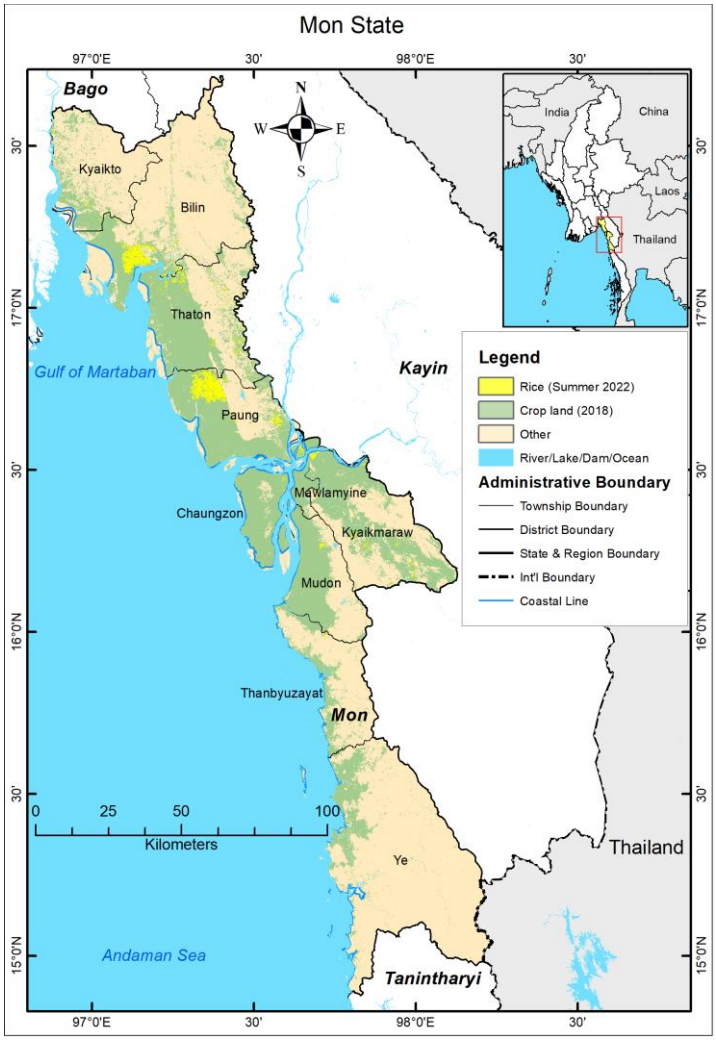
Figure 11. A post-monsoon rice map for the Bago region (A), a chart of area estimates compared with reported historical cultivation area (B), and a chart distribution of post-monsoon rice by township in the Bago region (C).

Figure 11 shows that Daik-U, Kawa, Oktwin, and Thayarwady townships contain more than 40 percent of the post-monsoon rice cultivation area in Bago. Post-monsoon rice areas are distributed over 28 townships, but most of these townships contain small rice cultivation areas.

d) MON STATE

Mon state is located in the coastal region of Burma. Figure 12 shows the post-monsoon rice area estimates for Mon, indicating that rice cultivation primarily occurs around the coastal estuaries plain area with adequate access to water resources in the dry season. The figure shows that post-monsoon rice cultivation is a small fraction of the total crop area. The total error-adjusted area was calculated to be 19,635 ha for Mon. This number aligns with the previously reported estimate from GAD and the statistical yearbook.

The post-monsoon rice cultivation area in Mon state is mainly distributed in Bilin, Paung, and Thaton townships, with these townships constituting more than 84 percent of the total post-monsoon rice cultivation area in the state (Figure 12).



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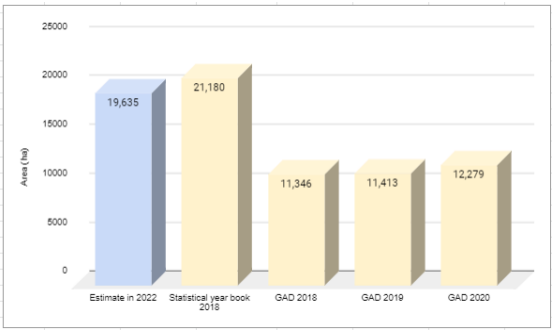

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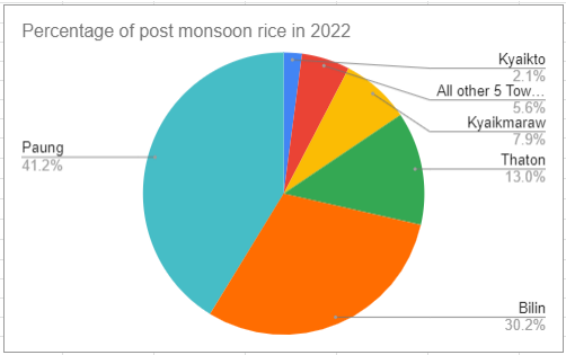
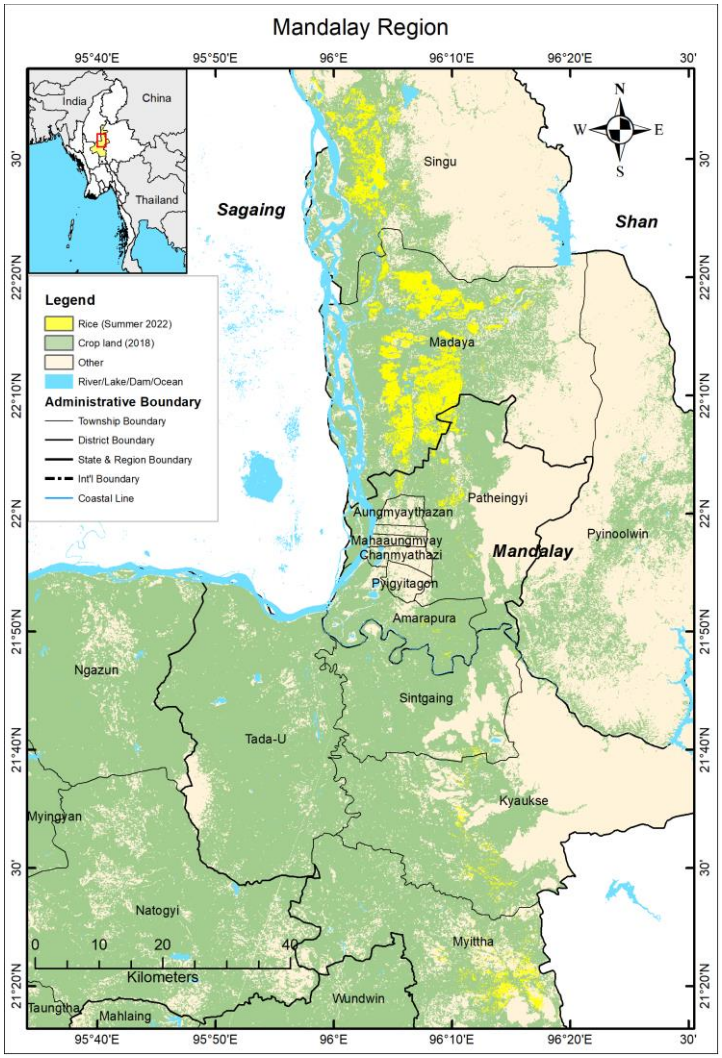


(C)

Figure 12. A post-monsoon rice map for Mon state (A), a chart of area estimates compared with reported historical rice area (B), and a chart distribution of post-monsoon rice by township in Mon state (C).

e) MANDALAY REGION

Mandalay is in the dry zone eco-region in Burma, where post-monsoon rice cultivation depends heavily on irrigated water. The post-monsoon rice cultivation area in Mandalay accounts for a relatively small fraction of the total crop area of the region. The rice map in Figure 13 below shows that post-monsoon rice in Mandalay is grown mainly in the floodplain area along the Irrawaddy River running through Madaya and SingU townships. The historical GAD numbers for Mandalay show a high variation, with a low of 6,907 ha in 2017 and a high of 66,664 ha in 2018, potentially due to data gaps by township in this period. The project team estimated the total post-monsoon rice area of 29,182 ha for Mandalay, which is lower than the average GAD data for the 2018–2020 period.



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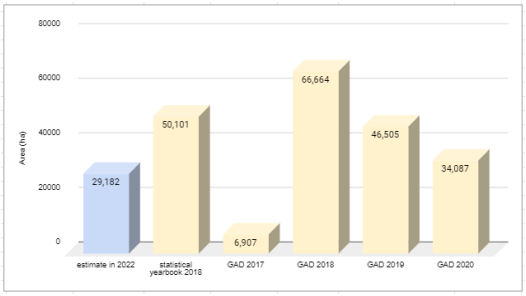

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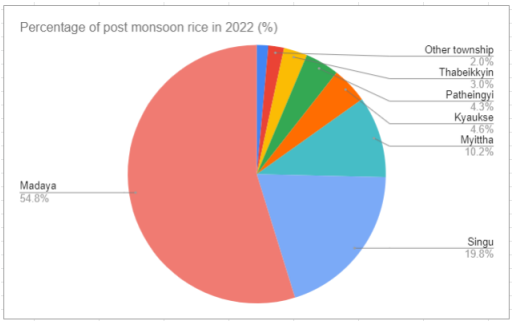


(C)

Figure 13. A post-monsoon rice map for Mandalay region (A), a chart of area estimates compared with reported historical rice area (B), and a chart of the distribution of post-monsoon rice by township in Mandalay region (C).

The distribution of post-monsoon rice area by township in 2022 for Mandalay also shows that most areas are located in the Madaya, Myittha, and SingU townships, with these townships containing more than 85 percent of the post-monsoon rice area in Mandalay.

A 2021 post-monsoon rice map was generated for Mandalay to investigate areas that were not cultivated in 2022 but were cultivated in 2021. Figure 14 below shows negative EVI values distributed mainly in the Amarapura, Madaya, and Patheingyi townships. The chart comparing the post-monsoon rice cultivation area in 2022 with 2018–2020 GAD data in Figure 15 shows the reduction of the cultivation area in the townships of Kyaukpadaung, Myingyan, Natogyi, and Wundwin. The decreased cultivation area in these townships reflects the increase in violence and conflict in the central part of Mandalay in 2022 according to conflict monitoring platforms (https://myanmar.iiss.org/).

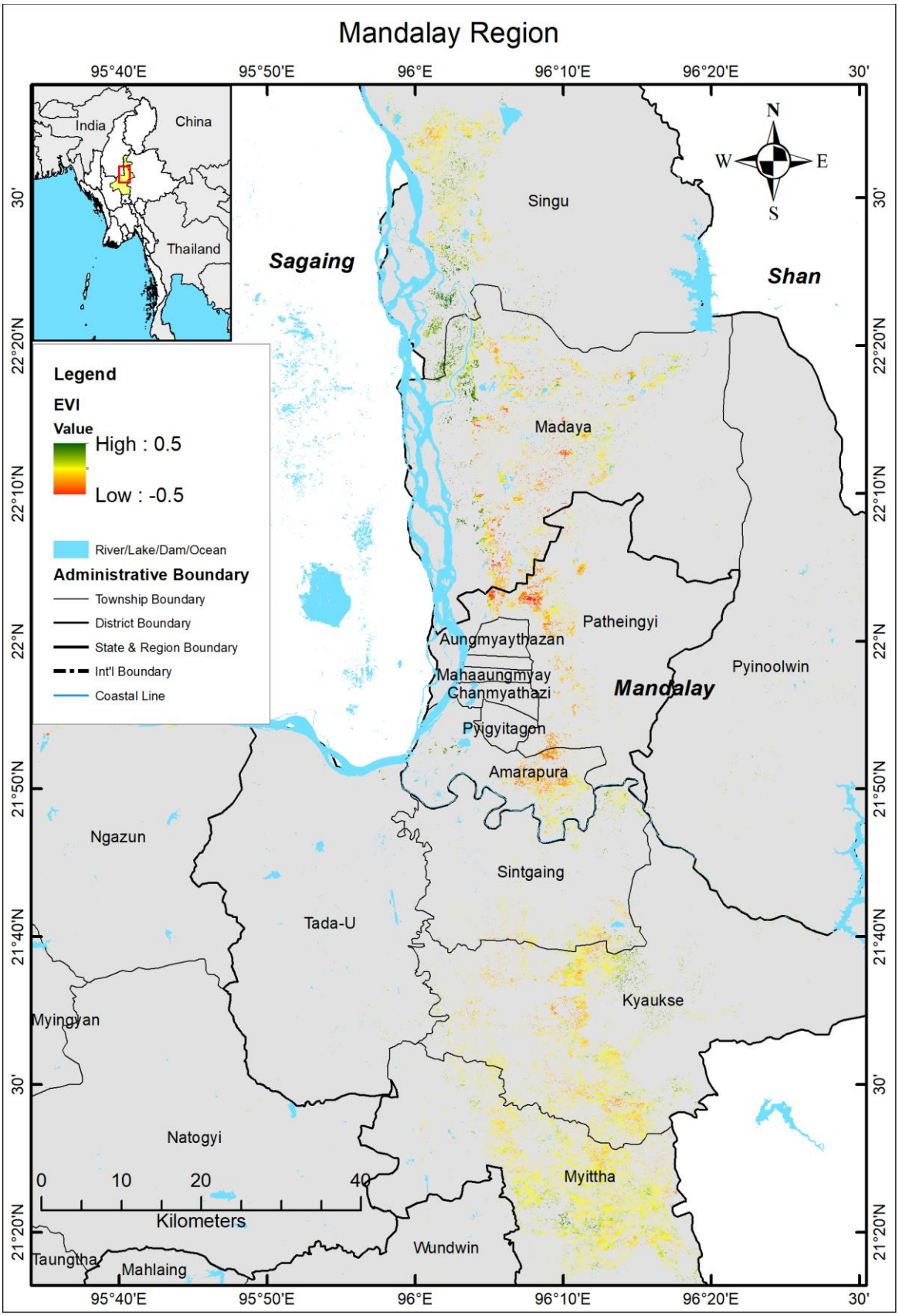


Figure 14. The cumulative anomaly for EVI in Mandalay for areas where post-monsoon rice was grown in 2021 but not in 2022. Red indicates fields that were most likely left barren.

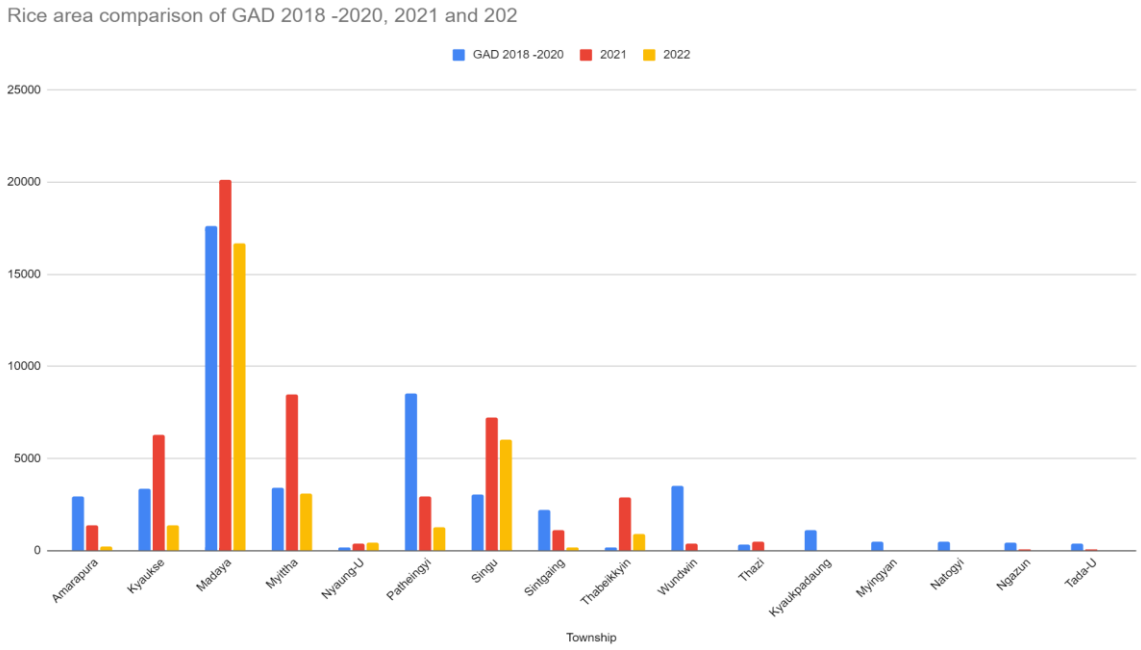
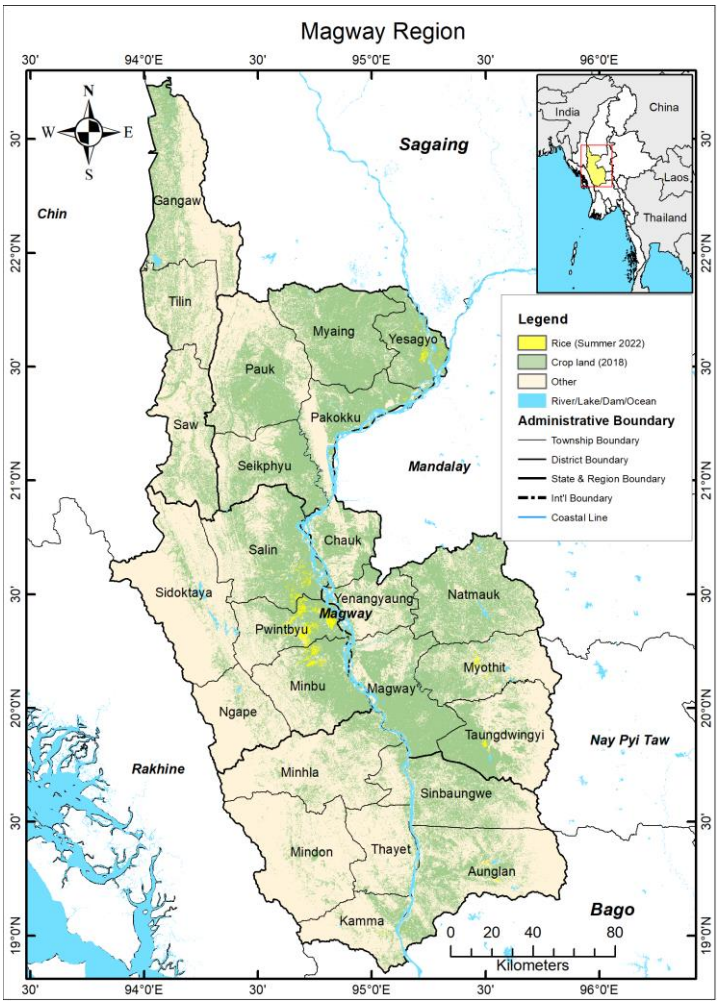


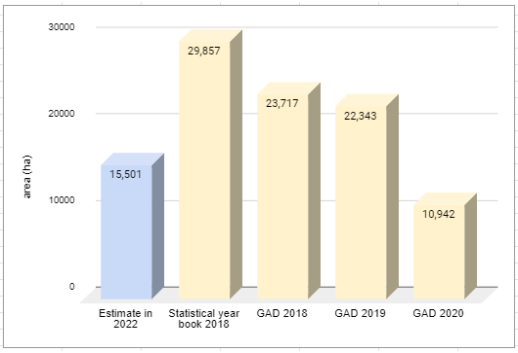
Figure 15. The cultivated area according to GAD (2018–2020) and satellite imagery (2021 and 2022) for different townships in Mandalay.

f) MAGWAY REGION

Post-monsoon rice cultivation forms a small portion of the total agricultural area in Magway. Post-monsoon rice fields are concentrated in the central area of the region, where adequate water resources are available. Historically reported rice areas vary between 10,942 ha and 29,857 ha according to GAD and the statistical yearbook, respectively. For the 2021 post-monsoon season, the project team estimated an area of 15,501 ha, which is considerably lower than the numbers reported for the years 2018–2019 but much higher than the 10,942 ha reported by GAD in 2020. The townships containing most of the post-monsoon rice cultivation area in Magway are Minbu, Pwintbyu, and Salin (Figure 16).



(A)



(B)

Figure 16. A post-monsoon rice map for the Magway region (A) and a chart of cultivation area estimates compared with reported historical areas (B).

g) SAGAING REGION

Croplands in Sagaing are primarily concentrated in the southern part of the region, and post-monsoon rice is grown in the areas downstream from the Thaphanzeik reservoir, which provides water for irrigation. The estimated post-monsoon 2021 rice cultivation area was much lower than historically reported numbers in the 2017–2019 period, possibly owing to changes resulting from drought in 2020 and the coup in 2021. For example, the statistical yearbook reports an area of 171,164 ha, and GAD reports a minimum of 122,767 ha. However, for 2020, GAD reported a cultivated area of 36,874 ha, whereas the project team estimates the 2022 rice area to be 45,143 ha, which is in line with the recent cultivation status in Sagaing.

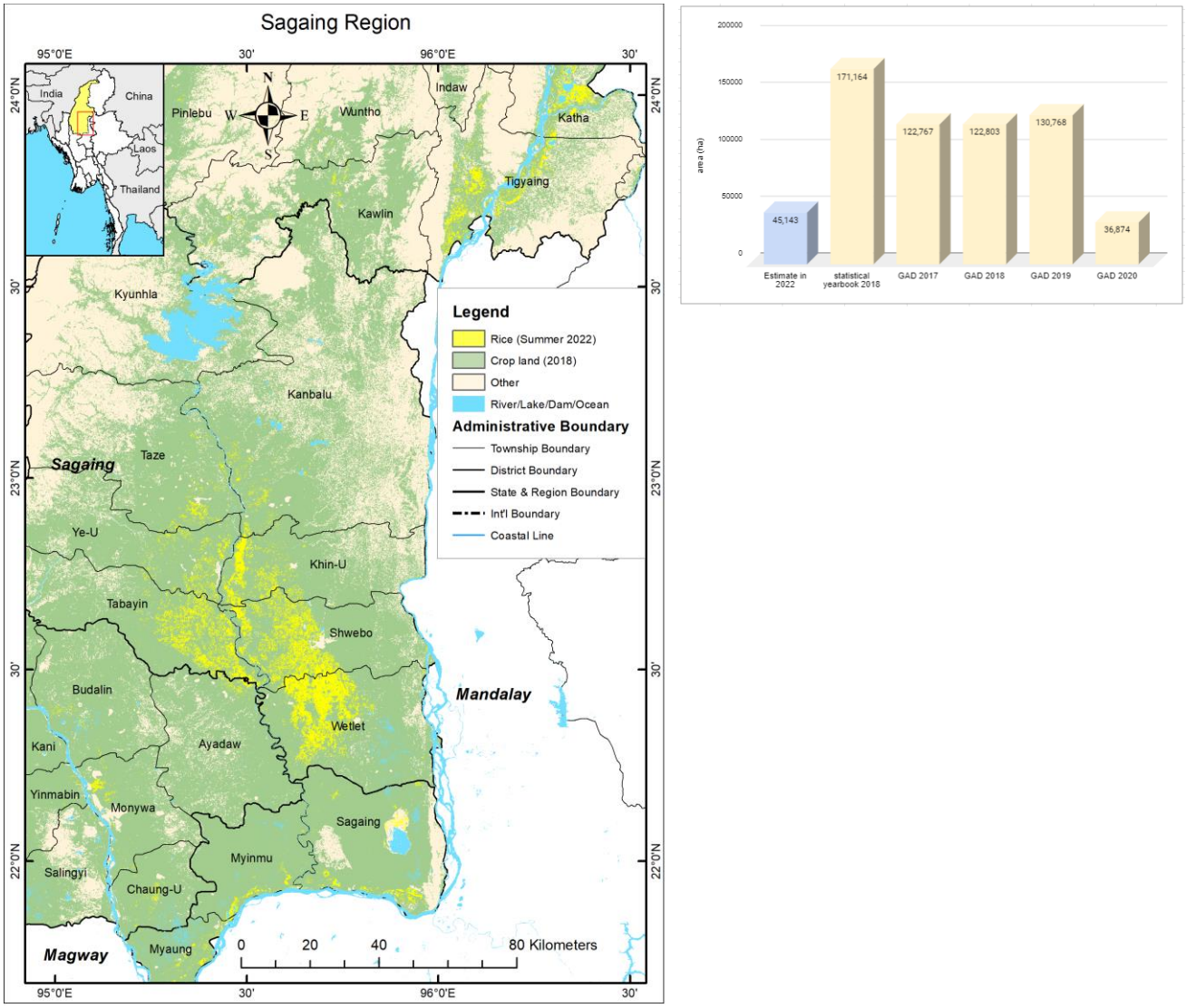


Figure 17. A post-monsoon rice cultivation area map for the Sagaing region (left) and a chart of area estimates compared with the historically reported cultivation area (right).

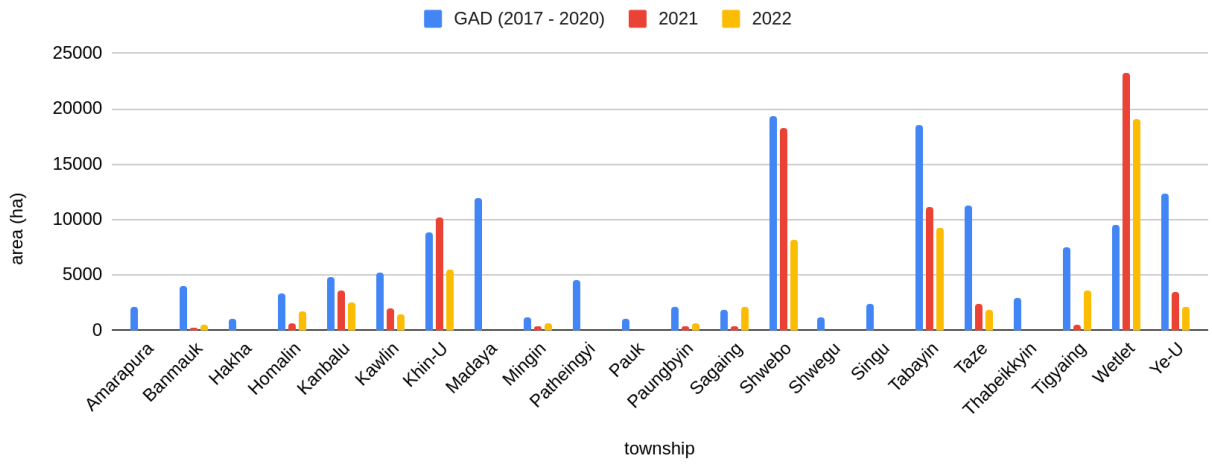
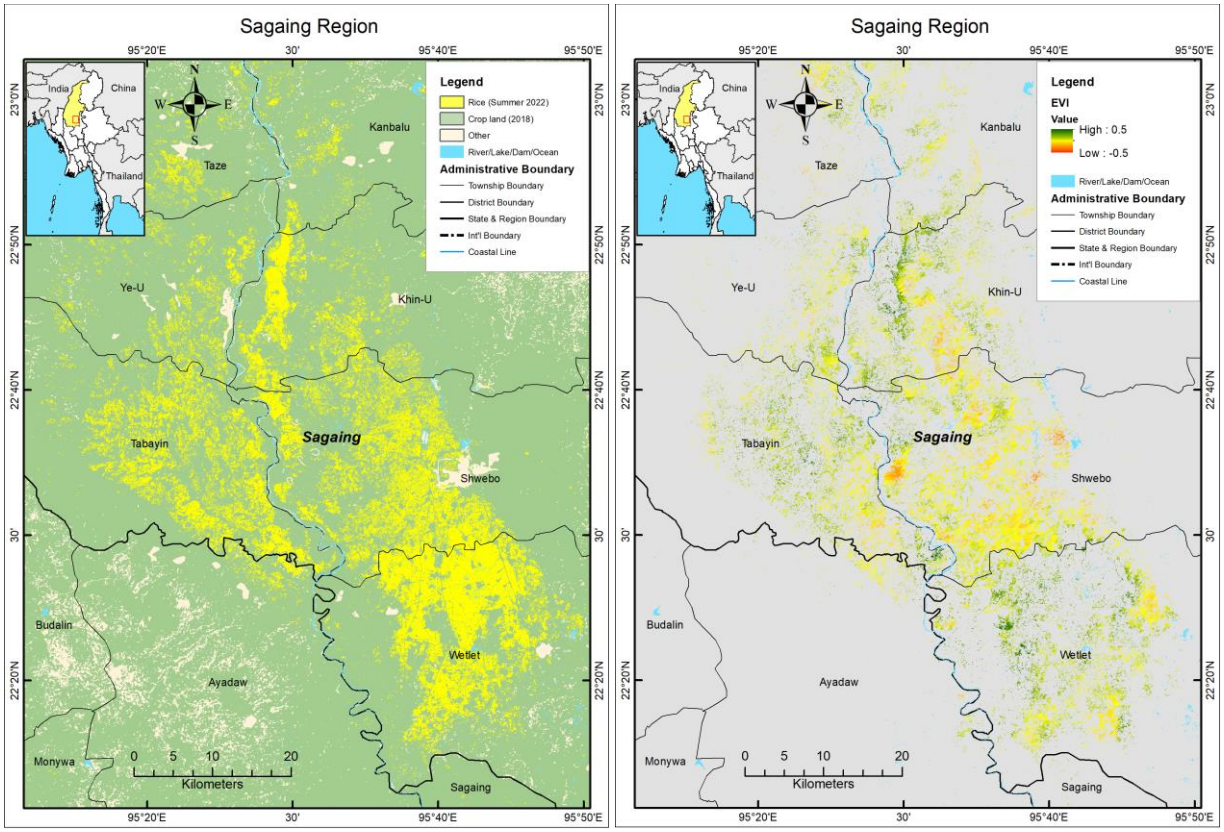


Figure 18. The cultivated area according to GAD (2017–2020) and satellite imagery (2021 and 2022) for different townships in Sagaing.

Figure 18 above shows that for most townships in Sagaing, the area of post-monsoon rice cultivation in 2022 has decreased compared to the average area during 2017–2020. The townships with the largest reductions in cultivation area are Kawlin, Madaya, Shwebo, Tabayin, Taze, and Ye-U.

Similarly to Ayeyarwady, a 2021 post-monsoon rice map was generated for Sagaing to investigate areas that were not cultivated in 2022 but were cultivated in 2021. However, due to difficult circumstances in 2021, including conflict and limited water resources, the cultivated area was also low in 2021. The map in Figure 19 below shows the cumulative EVI anomaly for these regions, where red indicates no vegetation was grown and green and yellow indicate that the plots were likely vegetated. The figure shows that some parts of the central region were barren, whereas crops might have been cultivated in the northern and southern areas.

This post-monsoon rice cultivation area reduction is related to the violence and conflict that has been present in southern Sagaing since the beginning of 2022, especially in Khin-U, Monywa, and Shwebo.

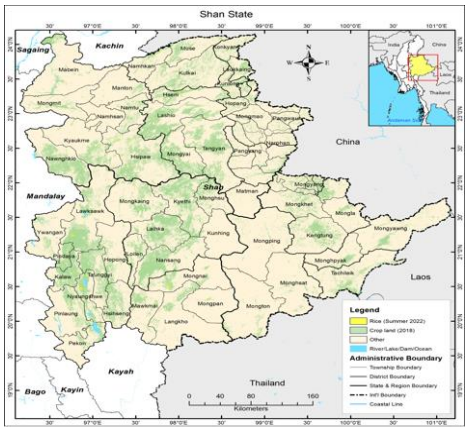


(A) (B)

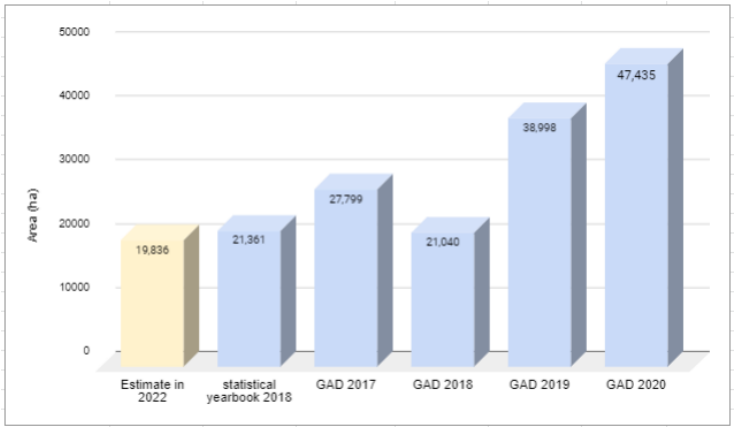
Figure 19. A map of the main post-monsoon rice cultivation area in Sagaing (A) and the cumulative anomaly for EVI in Sagaing for areas where post-monsoon rice was grown in 2021 but not in 2022, with red indicating fields that were most likely left barren (B).

h) SHAN STATE

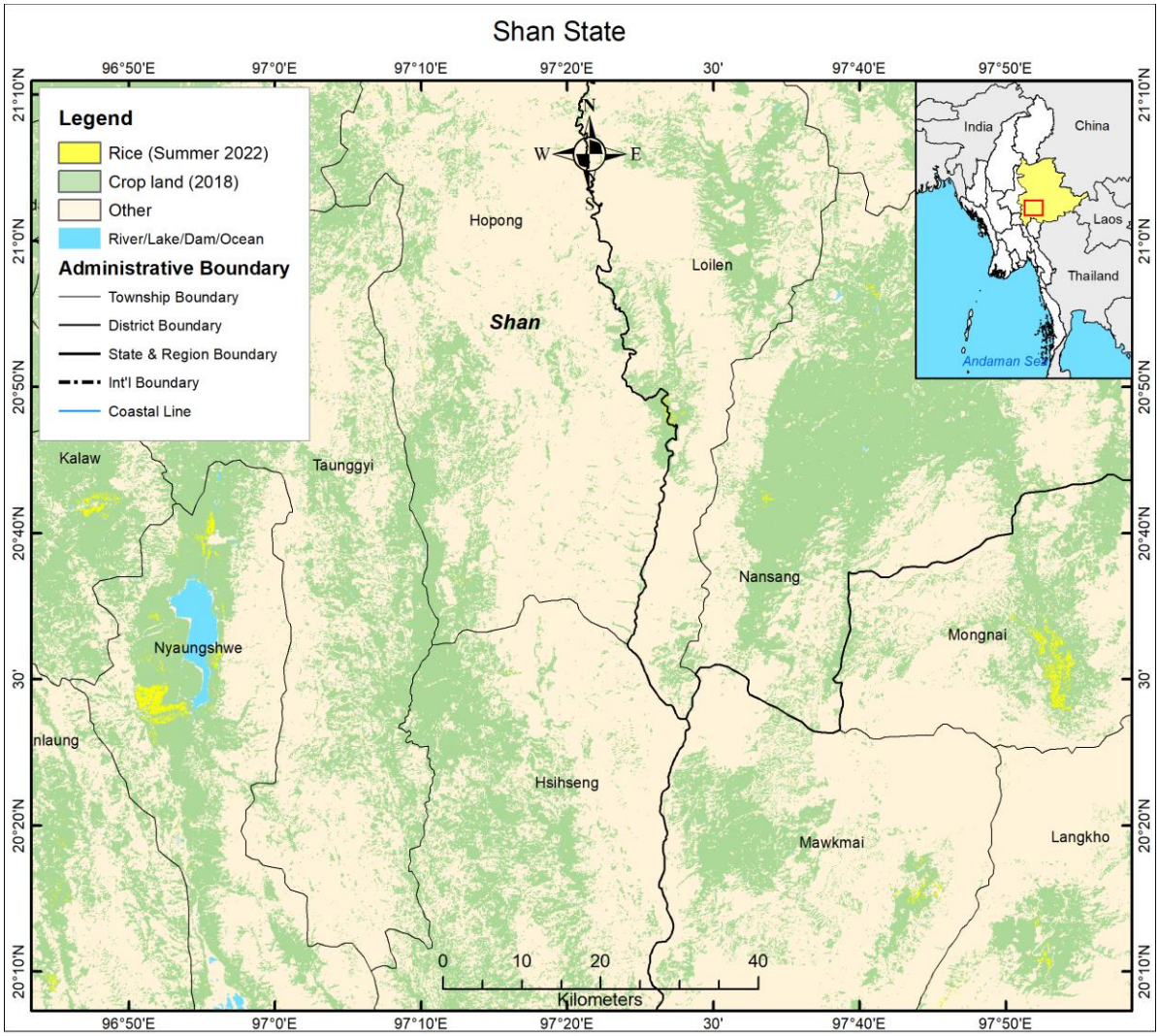
A small portion of the total cropland area in Shan state is used for post-monsoon rice cultivation. The project team estimates the total post-monsoon rice area at 19,836 ha, whereas historically reported areas have been between 21,040 and 47,435 ha. The total post-monsoon rice cultivated area in 2022 is slightly lower compared to the numbers reported by GAD and the statistical yearbook for 2018 and 2017 and significantly lower than the numbers reported by GAD for 2019 and 2020.



(A)



(B)



(C)

Figure 20. A post-monsoon rice cultivation area map for the Shan state (A and C) and a chart of area estimates compared with the historically reported cultivation area (B).

3. POST-MONSOON RICE PRODUCTION ESTIMATION

a) RICE CULTIVATION AREA ESTIMATES

Table 2 shows the total post-monsoon rice cultivation area with 90 percent confidence intervals and the GAD, U.S. Department of Agriculture (USDA), and National Statistics figures. The figures show that this report's estimate is lower than the officially reported historic numbers, with the total post-monsoon rice cultivation area for Burma estimated at 721,459 +/- 64.908 ha. This area estimate is about 25–35 percent lower than the GAD and National Statistics estimations, respectively. The most significant decreases in area were in Ayeyarwady and Sagaing, followed by Magway and Mandalay. In Bago, Mon, Shan, and Yangon, cultivated areas were in line with the value in previous years. The satellite imagery indicates that more fields remained barren in the post-monsoon season in Ayeyarwady compared to 2021. In Sagaing, cultivation has been challenging for the last couple of years due to conflict and water-related issues. Political instability and conflict could also be factors for the decrease in cultivated area in Magway and Mandalay.

Table 2. Area estimates for 2021 post-monsoon rice cultivation in Burma.

State or region	Area (ha)	90% confidence level (ha)	GAD estimate (ha)	USDA estimate (ha)	National statistics estimate (ha)
Ayeyarwady	349,841	34,984	507,758	537,680	570,411
Yangon	81,422	6,521	78,574	81,120	86,571
Bago	152,683	13,745	174,230	117,520	124,733
Magway	23,717	1,146	16,633	47,840	50,782
Mon	19,635	1,984	14,103	18,750	19,506
Sagaing	45,143	4,047	90,096	153,920	163,242
Mandalay	29,182	1,377	43,130	38,480	40,902
Shan	19,836	2,104	37,703	19,760	21,361
Total	**721,459**	**65,908**	**962,226**	**1,015,040**	**1,077,508**

b) RICE PRODUCTION ESTIMATES

Rice cultivation area estimates were used to calculate rice production using the IFPRI yield information for the post-/pre-monsoon period by state and region, calculated based on the

data of households interviewed from the third Myanmar Household Welfare Survey in 2022 (Table 3).

Yields of post-monsoon rice are generally higher than those of monsoon rice as farmers more often use high-yield rice varieties with more fertilizer and water controlled by the irrigation system. However, the IFPRI yield estimates for the 2021 post-monsoon season are lower than in previous years as fewer agricultural inputs were used. Yields ranged from a maximum of 3,987 kg/ha for Ayeyarwady to a minimum of 1,190 kg/ha for Mon.

Table 3. The indicative paddy yield estimates for the post-monsoon and monsoon periods by state and region (calculated by IFPRI).

State or region	Baskets per acre		Kgs per ha	
	Mean	Median	Mean	Median
Simple average of all observations	62	53	3,219	2,726
Sagaing	59	61	3,049	3,123
Bago	76	60	3,945	3,097
Magway	53	60	2,744	3,097
Mandalay	53	58	2,736	2,990
Mon	37	37	1,910	1,932
Yangon	62	67	3,223	3,442
Shan	43	40	2,203	2,065
Ayeyarwady	77	60	3,987	3,097

The total estimated post-monsoon rice production for 2022 is 2,623 +/- 196,000 tons (Table 4), considerably lower than the 5,019,000 and 3,553,000 tons reported by GAD and USDA, respectively. The USDA uses an expected yield of 3,500 kg/ha, whereas GAD reports yields per township, which are considerably higher. The largest decline was found for Ayeyarwady, followed by Sagaing, Mandalay, and Magway. While the cultivated area in Bago, Mon, Shan, and Yangon are quite similar to historical reported numbers, lower yields cause a decline in production. For the country, a 30–40 percent decline in total post-monsoon rice production may be due to less area having been cultivated and yields being lower than usual.

Table 4. The total production of 2021 post-monsoon rice in Burma, including the 90 percent confidence interval.

State or region	Yield - IFPRI (kg/ha)	Production (thousand tons)	90% confidence level (thousand tons)	GAD estimate (thousand tons)	USDA estimate (thousand tons)
Ayeyarwady	3,987	1395	139	2,708	1,882
Yangon	3,223	262	21	388	284
Bago	3,945	602	54	895	411
Magway	2,744	65	3	78	167
Mon	1,910	38	4	62	66
Sagaing	3,049	138	12	452	539
Mandalay	2,736	79	4	228	135
Shan	2,203	44	5	207	69
Total	**2,975**	**2,623**	**196**	**5,019**	**3,553**

4. CONCLUSION

Post-monsoon rice cultivation heavily depends on irrigation and, as such, water availability in lakes and reservoirs filled during the preceding monsoon season. Rainfall analysis shows that rainfall conditions during the 2021 monsoon season were generally favorable, resulting in sufficient water for most irrigation schemes. The Thaphanzeik reservoir is of particular concern as it has not had sufficient water in recent years, and the 2021 post-monsoon rice in Sagaing depends on it. However, satellite imagery shows that the water extent of the reservoir increased compared to the 2021 post-monsoon season, suggesting an adequate water supply for 2022.

Satellite imagery combined with a sampling approach and image interpretation were used to estimate post-monsoon rice cultivation area and production for eight regions in Burma in 2022. The analysis shows that the rice cultivation area has considerably declined in Ayeyarwady and Sagaing. In Ayeyarwady, some plots remained barren compared to 2021. The situation in Sagaing is more complicated due to a lack of water and conflict in the region in recent years, resulting in higher variability in cropping patterns. Post-monsoon rice cultivation in Magway and Mandalay concentrates on a few areas, which have also declined compared to recorded historical numbers. No decline was observed for Bago, Mon, Shan, and Yangon. As Ayeyarwady and Sagaing account for the largest area of post-monsoon rice cultivation, the project team estimates a total of 25–35 percent decline in the 2021 post-monsoon rice area.

Post-monsoon rice production has seen a larger decline than the total cultivation area. Due to weather conditions, the use of specific rice cultivars, soil, and water management, and the use of agricultural inputs, post-monsoon rice usually has higher yields compared to monsoon rice. However, 2022 yields were lower than expected. The higher cost of fertilizer, pesticides, seeds, and fuel for irrigation and transportation has led to a decline in both cultivated area and yield. This decline has resulted in a dramatic decline of rice production in absolute terms for Ayeyarwady and Sagaing but also in relative terms—i.e. the production of post-monsoon rice in relation to previous years—for Magway, Mandalay, Mon, and Shan. Lower yields combined with a decline in cultivated area might have led to the 30–40 percent decline in total post-monsoon rice production at the country level.

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