Issue brief

Advancing the monitoring of water-related Sustainable Development Goals in Myanmar

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1 Introduction

1.1 Scope and objectives

The Sustainable Development Goals (SDGs) were adopted in 2015 by the United Nations (UN) General Assembly as "a shared blueprint for peace and prosperity for people and the planet", with associated targets intended to be achieved by 2030. Out of a total of 17 interlinked goals, SDG 6 seeks to ensure access to clean water and sanitation for all, focusing on the sustainable management of water resources, wastewater and ecosystems. The targets associated with SDG 6 are to be achieved by monitoring and improvement of 8 indicators. Assessment of these indicators requires a considerable amount of data, which are in many countries not readily available. Also in Myanmar, challenges are posed to the national statistical system to collect, manage and report the necessary input data.

This issue brief explores the availability of geospatial data, in particular derived from Earth Observation (EO) from satellites, to monitor 4 water-related SDG indicators. Based on the status of data availability in Myanmar and the potential of innovative technologies and datasets, examples are given of how current knowledge gaps can be addressed. In addition, brief recommendations for future data collection and indicator assessment based on EO are provided.

1.2 Monitoring of SDG 6: institutional arrangements

Individual countries oversee national monitoring related to the SDGs through their national statistical system. They report to *custodian agencies*, which are designated international organizations responsible for compiling and verifying country data and metadata. Table 1 lists the custodian agencies for each of the indicators defined under SDG 6. To ensure that national data are consistent and comparable, the custodian agencies have published international standards and recommended methodologies for monitoring. Country data compiled and verified by the custodian agencies are published in the SDG 6 Data Portal[1], coordinated by UN-Water, to enable a comprehensive assessment of the overall progress towards SDG 6. All data in the SDG 6 Data are based on official national sources and have been approved by the respective country before publication.

Table 1: Overview of SDG 6 targets, indicators, and custodian agencies. Indicators highlighted in light green are the focus of this issue brief.

Target	Indicator	Custodian agency
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1 Proportion of population using safely managed drinking water services	WHO, UNICEF
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open	6.2.1 Proportion of population using (a) safely managed sanitation services and	WHO, UNICEF

[1] https://sdg6data.org/

Target	Indicator	Custodian agency
defecation, paying special attention to the needs of women and girls and those in vulnerable situations	(b) a hand-washing facility with soap and water	
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of domestic and industrial wastewater flows safely treated	WHO, UN-HABITAT, UNSD
	6.3.2 Proportion of bodies of water with good ambient water quality	UNEP
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time	FAO
	6.4.2 Level of water stress: freshwater withdrawal as a proportion of total renewable freshwater resources, after having taken into account environmental flow requirements	FAO
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	6.5.1 Degree of integrated water resources management	UNEP
	6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation	UNESCO-IHP, UNECE
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1 Change in the extent of water-related ecosystems over time	UNEP, Ramsar

1.3 Monitoring of SDG 6 in Myanmar

The Central Statistical Organization (CSO) of Myanmar plays a key role in monitoring and evaluation of the progress towards achievement of the SDG targets. A Baseline Report was published in 2017, which presents an overview of the availability of data required for monitoring SDG progress [1]. The report does not provide any quality assurance or validation of these data, but rather explores to what extent the required information for SDG indicator assessment can be provided by the national statistical system. Another relevant government publication is the National Indicator Framework (NIF) to support the Myanmar Sustainable Development Plan (MSDP) [2], which is aligned with the SDG framework.

Both reports highlight the need for spatially disaggregated, consistent data that can be applied for monitoring of water-related development goals in Myanmar. As the Myanmar branch of the lead UN development agency, UNDP Myanmar carries out activities to support implementation of the SDGs. Acknowledging the recent political developments in Myanmar, more than ever it is important to explore innovative sources of data to support monitoring and evaluation of progress towards the SDGs.

2 Water use and scarcity (SDG 6.4)

2.1 Explanation of indicators

SDG indicator 6.4.1 is defined as *change in water use efficiency over time* and is measured as the change in the ratio of gross economic value added by irrigated agriculture, industry and the services sector to the volume of water withdrawn over time (US$ / m^3). It is therefore a measure of the dependence of a country's (or, region's) economy on the abstraction of its water resources. If economic growth is not accompanied by an increased water use efficiency, this may indicate negative social or environmental impacts from overexploitation of water resources, as well as economic development potentially being unsustainable.

Box 1: Why monitor SDGs with satellites?

Over the last decade, Earth Observation (EO) has made the transition from being mainly applied in research contexts to being the fundamental technology underlying countless environmental monitoring systems. Technological advances related to sensors on board of newly launched satellites, the availability of **extensive time series** of information, **open access** to many global data archives, and the increase of computational power (including through cloud computing systems) have all contributed to the uptake of satellite data in operational systems. Furthermore, EO has proven a **cost-effective** way of covering large spatial extents, including transboundary areas, making it an ideal tool for monitoring across different spatial levels in the context of both river basins and countries. Although the minimum requirement of SDG progress reporting is one national aggregate per indicator, sharing **disaggregated** data greatly enhances the utility of the data for different user groups. This is particularly relevant for a large country such as Myanmar, with great spatial variability concerning landscape, climate, and demographics.

Building on these advantages of satellite remote sensing, a method was already developed for monitoring SDG 15 indicators across Myanmar [17]. There are however also **many relevant EO applications** which can support the assessment of SDG 6 indicators, including monitoring of rainfall, drought, water requirements, water productivity, land use / land cover mapping, and water accounting / general water resources assessments [3,4]. Expected benefits of SDG 6 methodologies relying EO include cost saving by reducing the need for in-situ observations, **improved accuracy**, and the opportunity for **change detection** [19]..

SDG indicator 6.4.2, *Level of water stress* (in %), is defined as *freshwater withdrawal as a proportion of total Renewable Freshwater Resources (TRFR), after having taken into account environmental flow requirements.* Freshwater withdrawal data from the main economic sectors are the same as those required for 6.4.1. TRFR is the long-term average annual flow of rivers and recharge of groundwater measured as a volumetric unit (e.g. km^3/year). Importantly, this indicator explicitly also considers Environmental Flow Requirements (EFR) to ensure that water needs of ecologically valuable systems are not overlooked, by subtracting EFR from TRFR.

The Food and Agricultural Organization of the United Nations (FAO), the custodian agency for SDG indicators 6.4.1 and 6.4.2, has published the recommended methodologies for their step-wise quantification [3,4]. A separate document with guidelines for EFR assessment to support indicator 6.4.2 is also available [5].

2.2 Data for Myanmar

The relevance of both indicator 6.4.1 and 6.4.2 to the Myanmar context is demonstrated by the fact that they were assimilated directly into the National Indicator Framework, as indicators 5.3.B and 5.3.C respectively. However, data providers and sources for regular monitoring were not identified in the NIF. In the CSO Baseline Report 6.4.1, no baseline value for Myanmar is mentioned due to a reported lack of data on water withdrawals. For 6.4.2, however, a reference value for the national level of water stress of **2.85%** is provided for the period 1998 – 2002. The source of this value is not specified.

In general, the global water information system AQUASTAT[1], managed by FAO, is considered the main data source for both indicators according to the recommended assessment methodologies. AQUASTAT should contain the hydrological data required for 6.4.1 and all data needed for 6.4.2. However, AQUASTAT in fact is merely a data repository that relies on submission of data by the individual countries. Where data are not available, FAO is responsible for generating estimates to be used in SDG monitoring.

Based on AQUASTAT data, FAO has recently published comprehensive reports for indicators 6.4.1 and 6.4.2, which contain data for all countries up to 2018 [6,7]. For Myanmar, national-level 6.4.1 values were estimated by FAO and are shown in Table 2 and Figure 1. A clear increasing trend can be observed, although values remain behind those of other countries in the region. However, it should be noted that the estimates are based

[1] https://www.fao.org/aquastat/en/

on several important assumptions and their accuracy cannot be verified. Regarding indicator 6.4.2, a constant value of **5.8%** is reported by FAO for the 2000 – 2018 period. Although this suggests an increase compared to the CSO baseline value, it is unlikely that this value has been stable over the years, thus its credibility is considered questionable.

Table 2: Water use efficiency in Myanmar for three distinguished sectors, as well as the overall annual average (2000 – 2018).

Year	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
Industrial	4.07	8.99	22.46	28.23	31.23	33.85	38.79	41.48	44.68	49.58	50.24
Irrigated agriculture	0.08	0.14	0.17	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.20
Services	1.41	2.81	5.00	5.21	5.74	6.40	6.88	7.56	8.15	8.87	9.12
Overall	**0.26**	**0.53**	**0.98**	**1.08**	**1.18**	**1.29**	**1.41**	**1.52**	**1.63**	**1.77**	**1.84**

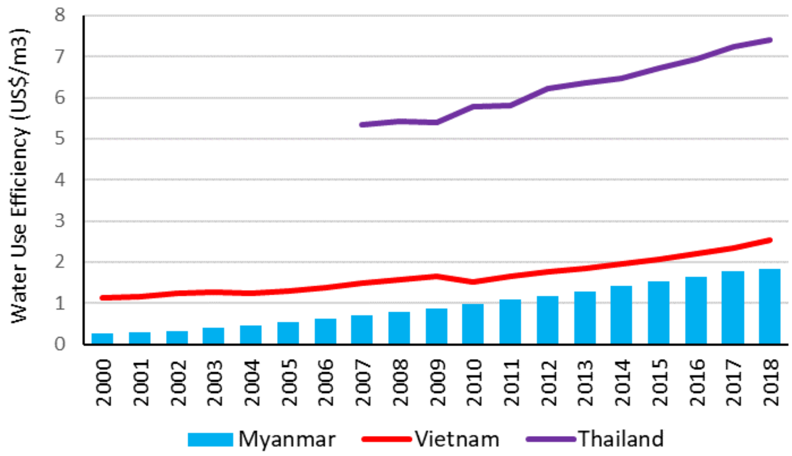

Figure 1: Water use efficiency in Myanmar for 2000 – 2018. Values for Vietnam and Thailand are provided for reference (source: FAO [6]**).**

2.3 The potential of satellite remote sensing

Although there is currently no mention of EO in the methodological guidelines prescribed by FAO to quantify the indicators, satellite remote sensing is generally considered to hold clear potential to support consistent, continuous and quantitative monitoring of both 6.4.1 and 6.4.2 [8]. **Water consumption** (actual evapotranspiration, ET_{act}) is a key metric for evaluating water use efficiency, which can be measured with satellite-based sensors [9]. In addition, biomass production can be computed based on satellite observations, enabling the calculation of biomass **water productivity** (BWP, in kg of biomass per m^3 of water consumed). This is a crucial indicator to express the productivity of agricultural areas, where biomass produced on agricultural fields can be subsequently converted to crop yield if the crop type is known (thus, allowing calculation of crop water productivity in kg of yield per m^3 of water consumed). This makes EO particularly suitable for assessing the agricultural component of 6.4.1, thereby covering the greatest water using sector in Myanmar. Land cover and crop classification based on open-access satellite information, available up to a 10m spatial resolution in the public domain[1], can support this type of analysis. To address the economic dimension of 6.4.1, data from EO should be complemented with financial data, such as market prices.

With regards to indicator 6.4.2, EO can support the assessment of total water withdrawals, again particularly in an agricultural context, as well as availability of freshwater resources. Multiple decades of monitoring have yielded databases of daily, spatial estimates of precipitation and soil moisture for Myanmar. In addition, data

[1] https://esa-worldcover.org/en

on lake and reservoir water levels and surface areas are available. Different metrics of water availability and water use derived from remote sensing can be integrated into basin-level **water accounts**, which provide a full picture of the water resources situation, stress levels, and opportunities for further development[1] [10].

To demonstrate the potential of EO data, Figure 2 shows annual maps of water consumption (left) and biomass water productivity (right) for agricultural areas in Myanmar in the year 2018. Agricultural lands were extracted based on the satellite-derived SERVIR-Mekong Regional Land Cover Monitoring System (RLCMS)[2]. From Figure 2, it is clear that water consumption can be mapped across the country, with the potential to aggregate values to any administrative or hydrological unit (basin) of choice. Various ET_{act} data sources are currently available in the public domain, most of which span the entire period from the early 2000s until present day, with a spatial resolution of 250 – 1000m. The BWP map in Figure 2 shows how differences in agricultural productivity can be perceived from spatial assessment based on EO data. In particular, the difference in water productivity between the paddy rice areas in the Ayeyarwady Delta, famously using a lot of water, and inland agriculture in the Dry Zone becomes clear.

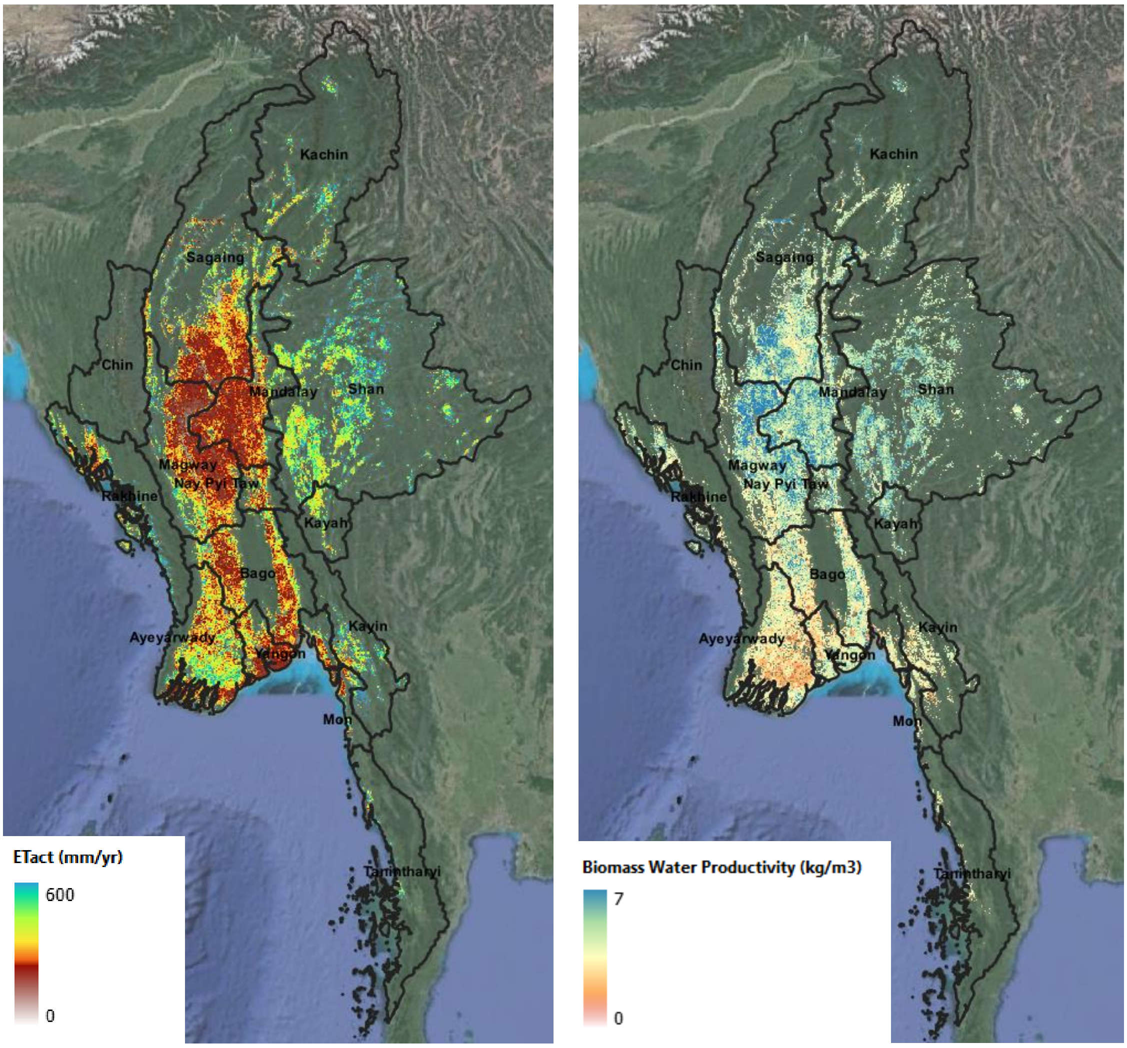

Figure 2: Water consumption (ET_{act}) (left), and biomass water productivity (right) in agricultural areas in Myanmar for the year 2018. Analyses were done using the Google Earth Engine platform based on the MOD16 ET_{act} and MOD17 Net Primary Production (NPP) data products.

[1] A list of basin- and country-level water accounting studies based on EO is found here: https://www.wateraccounting.org/publications.html
[2] https://servir.adpc.net/tools/regional-land-cover-monitoring-system

3 Proportion of transboundary basin area with an operational arrangement for water cooperation (SDG 6.5.2)

3.1 Status quo in Myanmar

SDG indicator 6.5.2 is defined as *the proportion of transboundary basin area with an operational arrangement for water cooperation.* “Basin area” includes both “river and lake basins” and “aquifers”. No baseline value is provided in the CSO Baseline Report. The indicator 6.5.2 progress report published by UNECE mentions that a total portion of 24.8% of Myanmar is covered by transboundary river basins [11]. Although these rivers are not specified in the report, it can be assumed that this extent refers to the Salween and Mekong Basins, which cover 127,500 km^2 and 21,955 km^2 of Myanmar soil, respectively. As Figure 3 shows, however, other basins also intersect the national border of Myanmar (e.g. the Ayeyarwady), but their transboundary extent is limited. Of the transboundary basin area identified in the UNECE report, 20% is listed to have an operational arrangement for water cooperation in place. Again, the corresponding river basin remains unnamed, but supposedly this refers to the Mekong Basin[1]. It is reported that Myanmar shares no aquifers with neighboring nations, although this may be a sign of a lack of data.

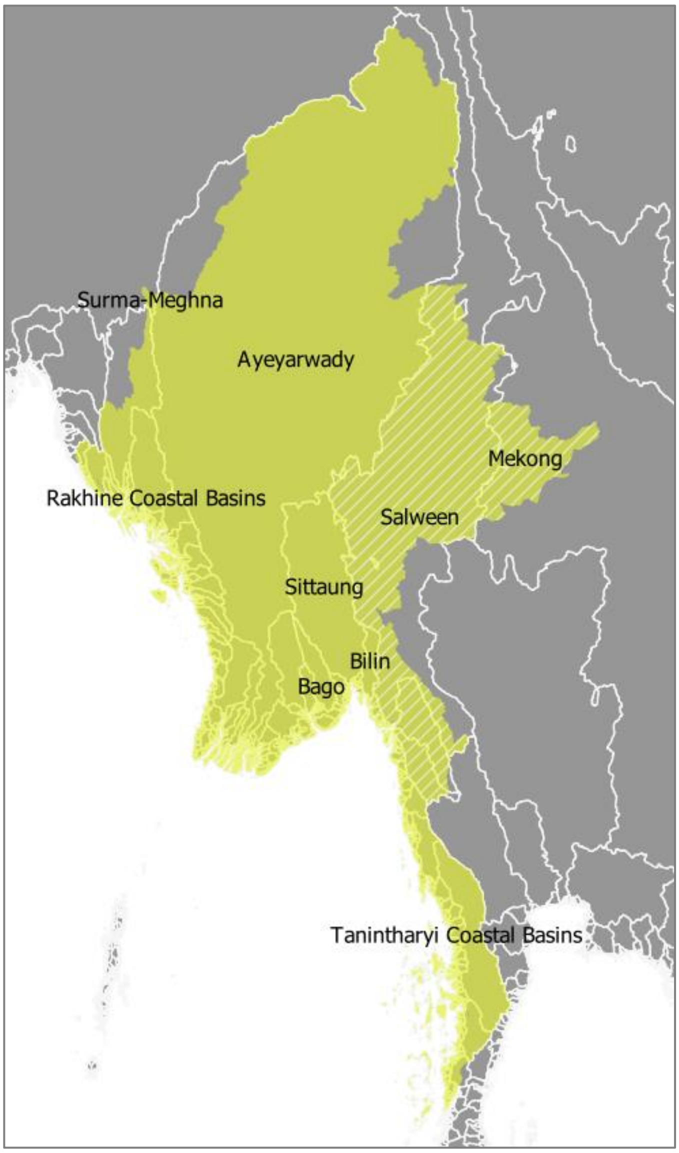

Figure 3: Major river basins of Myanmar. Basins with substantial transboundary extents are hatched in white. Data source: https://data.opendevelopmentmyanmar.net/

With regards to known transboundary water cooperation activities, Myanmar is one of the founding members of the Lancang-Mekong Cooperation framework and is a dialogue partner of the Mekong River Commission Secretariat[2]. In 2019, a Memorandum of Understanding between Myanmar and China on Cooperation in Water Resources Management which covers Ganges-Brahmaputra, Ayeyarwady, Mekong, and Salween.

3.2 The potential of geospatial data

Usage of EO techniques is not relevant for assessment of this indicator. However, the standard methodology recommended by UNECE lists several global spatial databases that can be consulted for information on

[1] According to the analysis presented here, the Mekong Basin only constitutes 15% of total transboundary basin area located within Myanmar.
[2] https://www.mrcmekong.org/about/mrc/dialogue-partners/

transboundary basins and existing cooperation agreements [12]. With Myanmar being one of 24 countries sharing transboundary basins which have not submitted data during the previous round of monitoring[1], it is likely that global data will continue to be the main source of information for the foreseeable future.

4 Change in the extent of water-related ecosystems over time (SDG 6.6.1)

4.1 Status quo in Myanmar

This indicator includes all freshwater ecosystems, encompassing inland wetlands, natural lakes, artificial reservoirs, as well as (brackish) mangroves. Properties of water-related ecosystems addressed under indicator 6.6.1 include spatial extent (surface area of lakes or wetlands), water quantity (change in water volumes within a lake or aquifer), and surface water quality (turbidity and nutrient load). The CSO Baseline Report does not provide a baseline value for indicator 6.6.1 for Myanmar. However, UNEP and UN-Water report a national-level baseline value of 6,533 km^2 as the spatial extent of water-related ecosystems for the latest five-year period of data (2011 – 2015), which constitutes an 8% increase compared to the 2001 – 2005 baseline period (Figure 4) [13]. Additional data for Myanmar, specifically targeted at quantifying SDG indicator 6.6.1, are available from the Freshwater Ecosystems Explorer online portal (Figure 5). This portal includes the opportunity to browse basin-level wetland extent, water quality, and mangrove extent data.

4.2 The potential of satellite remote sensing

As opposed to the SDG 6.4 indicators, the methodology for 6.6.1 already strongly relies on satellite remote sensing data [14]–[16]. Data reported in the indicator progress report and the Freshwater Ecosystems Explorer have been developed in accordance with the prescribed methodology. However, for Myanmar there are still data gaps which can be addressed by development and application of dedicated earth observation techniques. For example, no data is available on the extent of vegetated wetlands during the historical baseline period (2001 – 2005). This could be obtained by developing a classification methodology based on satellite imagery such as from the Landsat program, or by using a readily available land cover product such as the SERVIR-Mekong RLCMS. The latter contains annual satellite-derived land cover maps (1987 – 2018) for Myanmar, including a wetland class.

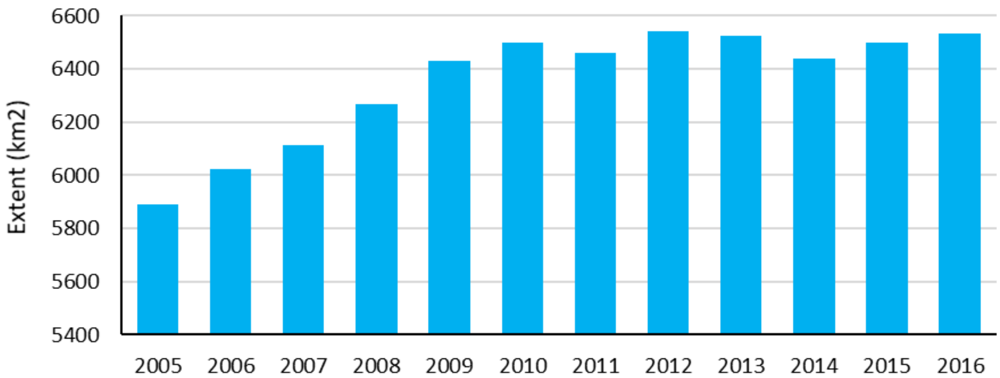

Figure 4: Spatial extent of water-related ecosystems in Myanmar (data source: UNEP / UN-Water[2]).

[1] https://unece.org/environmental-policy/water/transboundary_water_cooperation_reporting
[2] https://www.sdg6data.org/country-or-area/Myanmar

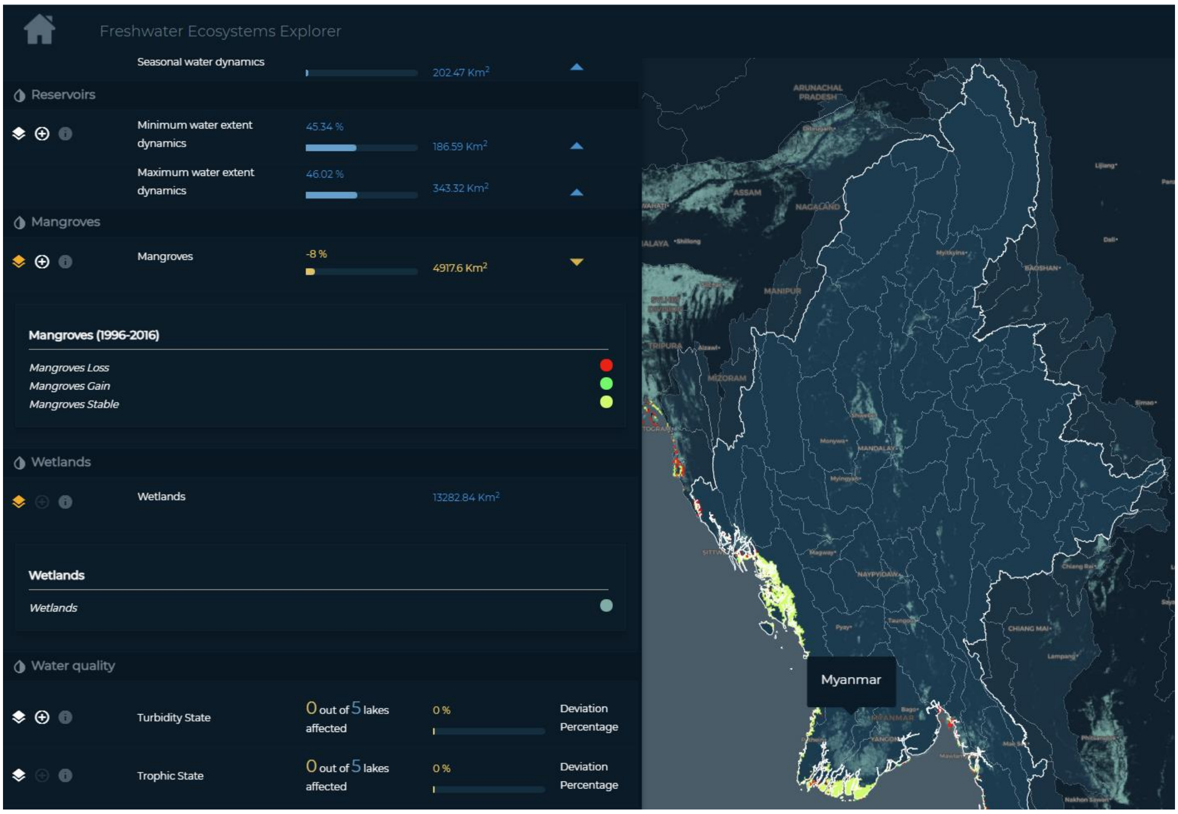

Figure 5: Screenshot of the Freshwater Ecosystem Explorer, which was developed to evaluate SDG indicator 6.6.1 (https://map.sdg661.app/). By clicking on the basins, data on each of the 6.6.1 sub-indicators can be viewed.

Another potential application of high-resolution satellite remote sensing data, is the reporting of disaggregated data for particular water-related ecosystems. Figure 6 provides an example for Inle Lake, where an archive of satellite-derived data was used to investigate differences in surface water extent between a baseline period (2000 – 2004) and the year 2018. Red and pink colors in the map show areas, particularly at the edges of the lake, which are no longer permanently inundated by 2018. At the same time, seasonal surface water increasingly occurs in areas located further from the lake, most likely due to diversion and management of water for agriculture.

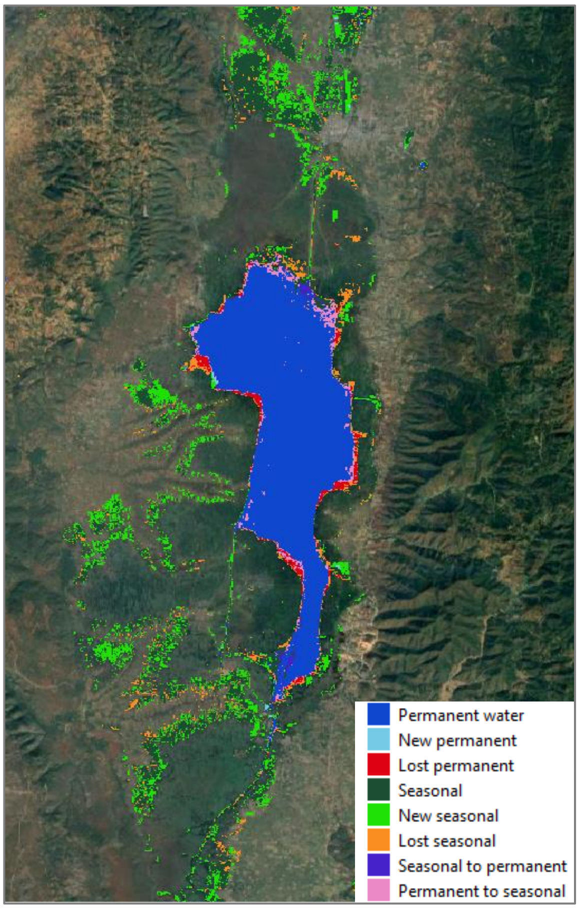

Figure 6: Water transitions around the Inle Lake Ramsar Site, exploring hydrological dynamics of the ecosystem between the baseline period (2000 – 2004) and 2018 (Data source: https://www.sdg661.app, founded by UNEP, Google, and the European Commission).

5 Conclusions and recommendations

This issue brief explores the potential of Earth Observation (EO) technologies for advancing the monitoring of four water-related SDG indicators in Myanmar. As demonstrated, the applicability and current use of EO-derived data for this purpose differs per indicator, but overall a clear potential of using Earth Observation (EO) technologies for monitoring water-related SDG indicators is identified. Some indicator-specific conclusions and recommendations can be provided as follows:

- A striking observation is that the methods recommended by FAO for assessing indicators **6.4.1** and **6.4.2** currently do not incorporate any EO component. However, EO could provide significant added value by mapping actual water consumption and the productivity associated with this water use, which are key metrics directly related to the nature of these SDG indicators. For this reason, and also considering the lack of alternative data sources for Myanmar, it is recommended to pursue follow-up EO analyses for evaluating water use efficiency and water stress across different spatial scales in Myanmar. This would not only support SDG monitoring, but also generate data to support implementation of the Myanmar National Indicator Framework (NIF).
- Concerning indicator **6.5.2**, EO has less direct relevance. A key conclusion from this issue brief is that the current progress reported by UNECE for Myanmar regarding transboundary cooperation activities cannot be linked to individual basins, indicating a need for more transparent and specific reporting of this indicator.
- Indicator **6.6.1** differs from the other indicators presented in this document, as its underlying methodology already explicitly includes EO-based analysis of water-related ecosystems. Online, publicly accessible datasets and information portals exist which provide highly relevant information for Myanmar at different spatial levels, and for different kinds of ecosystems. It is recommended that these resources are explored thoroughly for monitoring and evaluation of indicator 6.6.1 in Myanmar. Recommendations for additional next steps include the use of EO for generation of data on wetlands extent for the required baseline period (2001 – 2005) which is currently non-existent, and dedicated analyses for valuable freshwater ecosystems such as the Inle Lake wetland area.

To summarize, usage of EO-based data and information can greatly help to address the data and knowledge gaps that are associated with the monitoring of SDG indicators 6.4.1, 6.4.2 and 6.6.1 in Myanmar. Significant potential remains for further capitalizing on the advantages provided by EO-derived data collection in, which include cost-effective coverage of large and remote areas, flexibility regarding spatial scales, and easy access to (national and transboundary) data.

6 References

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