EO4SD: satellite based services for water resources management
2019 Dec 2   |   World Bank, Washington DC

Norman Kießlich, GeoVille
Content

EO support for SDG indicator reporting

SDG Indicator  6.6.1
   Objectives
   Methodology
   Results

SDG Indicator 15.3.1
   Objectives
   Methodology
   Results
Water Related Ecosystems
SDG 6.6.1
SDG 6.6.1 – Definition & Objectives

UN Sustainable Development Goals (SDGs)
- **Target 6.6**: By 2020, protect and restore water-related ecosystems
- **Indicator 6.6.1**: Change in the extent of water-related ecosystems over time

**Objective**
Wetland identification and delineation with the aim to support national and regional agencies to monitor wetlands in a cost-effective and sustainable way → large-scale mapping
SDG 6.6.1 – Definition & Objectives

Article 1.1: "...wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."

Article 2.1: "[Wetlands] may incorporate riparian and coastal zones, including marine wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands."

Highly dynamic environments → time series analysis

Focus on physical properties – measurable
SDG 6.6.1 – Methodology (Data availability)

**Optical:** Sentinel-2A since November 2015

**Radar:** Sentinel-1A since April 2014

**Other data used:** Landsat 5, 7, 8 and SRTM 30m DEM
Optical-based
• Combining multi-spectral information
• Enhancing spectral signatures making use of water absorption in NIR/SWIR
• Unsupervised and supervised classification or thresholding approaches

Challenges:
• Clouds
• Confusion with shadows
• Dense vegetation

Radar-based
• SAR sensors sensitive to dielectric properties (moisture content) and geometric attributes (roughness)

Challenges:
• Sandy/arid regions
• Confusion with other flat surfaces
• Dense vegetation
SDG 6.6.1 – Methodology (Processing)

Water / Wetness indices

SENTINEL-2 SCENE

NDMI

mNDWI

Spectral Indices

Water / Wetness detection

Water Probability

Water Extent

Wetness Probability

Wetness Extent

Topographic Wetness Index

Digital Elevation Model

TWI
SDG 6.6.1 – Methodology (Processing)

**Optical Water/Wetness Masks with Gaps**

**Filter SAR Water/Wet**

**Optical-SAR Fusion**

**Fused Water**

**Fused Wetness**
SDG 6.6.1 – Methodology (Processing)

WATER FREQUENCY
WETNESS FREQUENCY

FEB 2017
JAN 2017
WATER MASKS
WETNESS MASKS

Base product

CLASSIFICATION

WWPI
WETLAND PROBABILITY

Water Wetness Probability Index = \[\frac{\sum \text{water} + (0.75 \times \sum \text{wet})}{n} \times 100\]
Based on the Water/Wetness frequencies and the Water Wetness Presence Index (WWPI) the wetland probability map is derived using a rule-based fusion.

- High wetland probability
  - Permanently wet areas
  - Temporarily flooded with high WWPI
- Medium wetland probability
  - Temporarily flooded with medium WWPI
- Low wetland probability
  - Temporarily flooded with low WWPI
SDG 6.6.1 – Methodology (Classification)

GlobWetland Africa
Senegal
SDG 6.6.1 – Methodology (Verification/Validation)
SDG 6.6.1 – Results

Uganda National Wetland Inventory

Baseline: 2016/17
SDG 6.6.1 – Summary & Outlook

✓ Optical and radar based product to detect water and wet surfaces
  • Water and Wetness Frequencies
  • Water and Wetness Presence index → Delimitation water-related surfaces/ecosystems
  • Application of use case specific classification

✓ Highly automated production via Sentinel-1 and Sentinel-2 data streams

✓ Product has been externally validated by European Environment Agency with good overall accuracies for water and wetness classes over Europe (>92%).

✓ Contribution to SDG monitoring of „water-related“ ecosystems

✓ Scheduled implementation as SDG 6.6.1 API-based service to enable capacities of national stakeholders
Land Degradation
SDG 15.3.1
SDG 15.3.1 – Definition & Objectives

Good Practice Guide of UNCCD (Version 1.0, 2017)

- Documents the methodology for reporting on SDG
- SDG 15.3.1. is subdivided into three sub-indicators
  - Land cover and land cover changes
  - Land productivity changes and
  - Carbon stock changes
- For each indicator, changes have to be assessed and depicted as
  - (i) positive or improving,
  - (ii) negative or declining, or
  - (iii) stable or unchanging.
SDG 15.3.1 – Definition & Objectives

Baseline:
• Evaluation of changes in the sub-indicators to determine the Proportion of land that is degraded over total land area (%)
• One out all out (1OAO) principle
• Base year = 2015
• Initial quantification and assessment for the sub-indicators during the reference period 2000-2015. All future changes are assessed relative to the baseline value.

Reporting:
• Every 4 years, starting in 2018
• Custodian Agency: UNCCD
• Reporting as part of the National Policy on Public Sector Monitoring and Evaluation (2013) and through the Results and Reporting Framework (RRF) for the NDPII, and the National Standard Indicator Framework (NSI).
SDG 15.3.1 – Methodology

Sub-indicator
- Land cover
- Land productivity
- Carbon stock

Metric
- Area
- NPP
- SOC

Baseline Status ($t_0$) sub-indicators
- ND
- D
- P
- S
- N

Monitoring Period ($t_1$) sub-indicators
- Positive
- Stable
- Negative
- Stable

Total Area of Degraded Land
- Degraded land ($t_1$)
  - Positive
  - Stable
  - Negative
- Degraded land ($t_0$) that remains degraded ($t_1$)

Indicator 15.3.1
- Proportion of land that is degraded over total land area
- Total area of degraded land ($t_1$)
- Total land area
SDG 15.3.1 – Methodology

Land Cover and land cover change

- Satellite Data used: Landsat-7/8 and Sentinel-2
- Starting point:
  - Baseline land cover classification for 2015
  - Based on optical multi spectral Landsat-8 data (30m)
- Derived **fully automated**
- Methods and processing chain **already extensively applied** in various national wall-to-wall LC classifications
- Training data:
  - Local in situ data or global independent datasets
SDG 15.3.1 – Land Degradation
## SDG 15.3.1 – Land Degradation

Change detection and quantification

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>Forest Land</td>
</tr>
<tr>
<td>Forest Land</td>
<td>432,673</td>
<td>756</td>
</tr>
<tr>
<td>Grassland</td>
<td>256</td>
<td>525,907</td>
</tr>
<tr>
<td>Cropland</td>
<td>1,785</td>
<td>1</td>
</tr>
<tr>
<td>Wetlands</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Settlements</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other Land</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

![Graph showing change detection and quantification of land degradation](image)
SDG 15.3.1 – Land Degradation

Overview

- Continuous variable, describing the ability of the land to sustain life
- defined as the average time in the year where the vegetation density is above a certain threshold
- Time series analysis of the NDVI are applied as a proxy for the vegetation productivity
- Annual Land productivity is calculated using the smoothed NDVI time series and values above a threshold of NDVI
- Derived index is stable in terms of outliers and can be interpreted as the fraction of time where a certain pixel was covered by vegetation (proxy for vegetation health)
Annual land productivity estimates were derived for the period 2000 to 2018.
SDG 15.3.1 – Results

Land Productivity Assessment
SDG 15.3.1 – Results

Land Degradation Assessment

Based on
- Land cover changes and
- Land productivity changes

Application of „One-Out-All-Out“ principle as described by UNCCD


Area (ha): 121,368 ha
Area (%): 0.5%
SDG 15.3.1 – Results (Verification/Validation)
Mt Elgon National Park – Western Area

Report from stakeholder:
Degraded forest and changing boundary of the protected area in Western Elgon landscape.
SDG 15.3.1 – Results (Verification/Validation)

Mt Elgon National Park – Western Area

Assessment
The analysis revealed clear degradation patterns in the western part of the Mt. Elgon National Park, aligning with the reports from the local stakeholders.
Thank you for your attention