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Photo: A woman pumps water from a small reservoir.
Credit: Peter Casier/CCAFS.

Evolution of small reservoirs in Burkina Faso

Technical report

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Research highlights

- This study has revealed a significant increase in the number of small reservoirs (SRs) in Burkina Faso from 2002 to 2014, with a current total of 1,033 SRs (of 1 hectare [ha] or more).
- Most SRs are located in the Nakambe sub-basin (603), with the fewest in the Comoe (15).
- The areas (catchment of buffer zone) around most SRs experienced increased anthropogenic influence between 2002 and 2014.
- The highest increase in anthropogenic influence occurred within a 5-kilometer (km) buffer zone around the reservoir, with the main contributing influences being changes in cropland area.
- The observed anthropogenic influences on SRs substantiate calls for improving the sustainability of SRs in Burkina Faso.

Introduction

Small reservoirs (SRs) are important infrastructures for providing water for a wide range of activities in Burkina Faso and other semiarid environments. In recent years, SRs have become even more important, considering the effects of climate change and variability such as erratic rainfall patterns, recurrent droughts and floods, delays in the onset of the rains (Laux et al. 2008), increased incidence of in-season dry spells (Lacombe et al. 2012), and high evapotranspiration rates. SRs provide vulnerable rural communities with water for multiple purposes, including domestic and agricultural uses (McCartney et al. 2012; Venot et al. 2012). However, a number of external factors are negatively influencing the sustainable uses of SRs. Rapid population growth (Zuberi and Thomas 2012) and its attendant human-induced activities are a threat to the quality of water in SRs, as are agricultural extensification and intensification around SRs, including the increased use of inorganic fertilizers

As part of the objectives of WLE in Africa project, the geographical diversity and historical evolution of SRs in Burkina Faso have been analyzed, as well as the resilience of their socio-ecological systems. The purpose of this brief is to report on the distribution and historical evolution of SRs between 2002 and 2014 in relation to other land use and land cover.

Research data and method

Landsat satellite images were analyze to determine the location and distribution of SRs in Burkina Faso and map associated land use and land cover (LULC). Fifteen Landsat tiles, covering Burkina Faso, were downloaded free of charge from the global visualization viewer (GLOVIS) of the United States Geological Survey (USGS) for 2002 and 2014. The Landsat data were processed and images classified with an accuracy range of approximately 81% to 90% for the LULC classification.

The catchment area around forty-one SRs selected for in-depth study with the W4F project were delineated using a Digital Elevation Data (DEM). LULC changes were analyzed for the SRs by determining an index factor that indicates the level of anthropogenic influence on and around them.

Distribution of small reservoirs in Burkina Faso

Analysis of the Landsat images revealed that there are 1,033 small reservoirs with a surface area of 1 ha or more in Burkina Faso. Figure 1 shows the distribution of the reservoirs, indicating that the Nakambe sub-basin has the most SRs (603), while Comoe has the fewest (15). The Mouhoun and Nakambe sub-basins jointly have the smallest percentage of reservoirs in low-impact zones (~8%), whereas Niger has the highest percentage (33%) Forkuor et al (forthcoming).

In assessing the number of SRs that fall within the period of 2002 to 2014, a total of 620 SRs were found in 2002, which is 40% short of the overall total in 2014. Available data for 1992 indicate a total of 541 small reservoirs, which is closer to the number recorded in 2002.

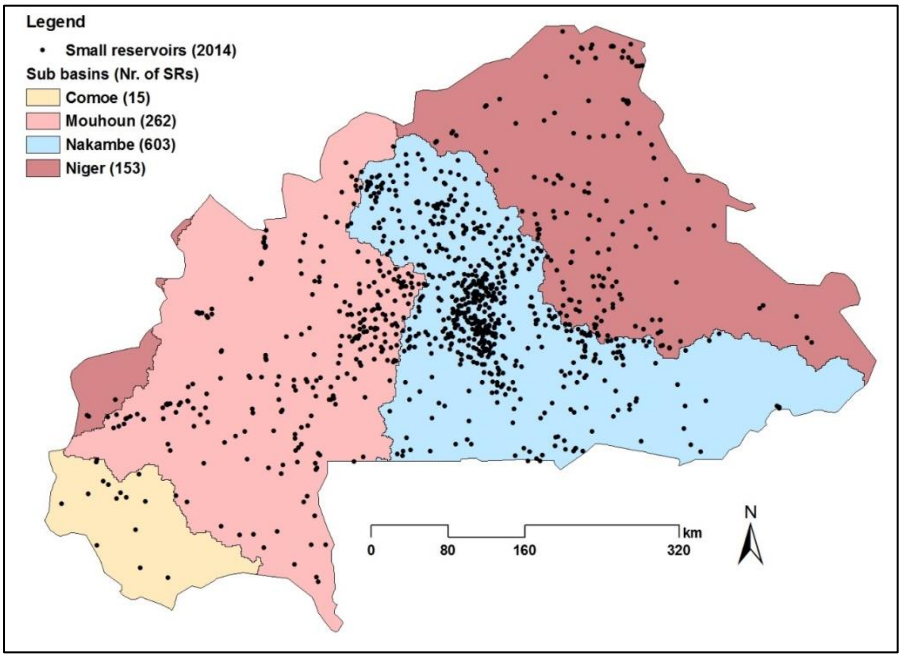

Figure 1: Distribution of small reservoirs in Burkina Faso as of December 2014.

Evolution of small reservoirs between 2002 and 2014

LULC changes from 2002 to 2014 were determined for the SRs by analyzing the main LULC classes around them. An index of anthropogenic pressures, defined as the ratio of the sum of two LULC classes [(cropland) + (artificial surfaces)] to the LULC class [(vegetation)], was used as an indication of the level of anthropogenic influence around a SR. Anthropogenic indices were extracted based on four geographical units around the forty-one small reservoirs selected for the Water for Food project. The geographical units used are 5-, 10- and 50-km buffers around the SRs and their respective delineated watersheds.

Figure 2 shows trends in anthropogenic influence for the different spatial units over time, with the blue bars depicting the number of SRs that experienced an increase in anthropogenic index between 2002 and 2014. The brown bars represent reservoirs that experienced reduced anthropogenic influences between 2002 and 2014.

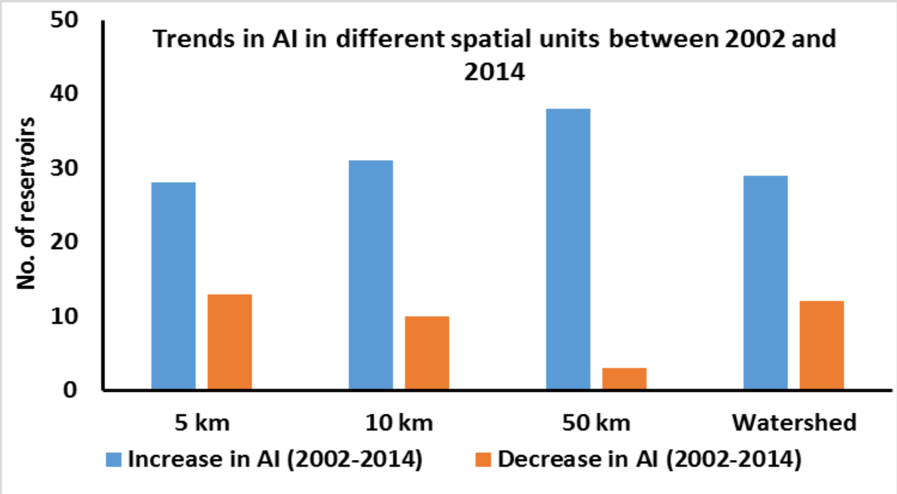

Figure 2: Trends in anthropogenic index (AI) across different spatial units between 2002 and 2014.

The results reveal that majority of reservoirs witnessed an increase in anthropogenic index between 2002 and 2014. The highest change was recorded in the 5-km buffer around Yamtenga, due to an exponential increment in artificial surfaces (bare areas, laterite and tarred roads, settlements, houses, etc.) as a result of high urbanization. However, for a sizeable proportion (24–30%), anthropogenic index reduced in the 5- and 10-km buffer zones as well as in the watershed regions, which did differ from one spatial unit to the other. Results at the 50-km buffer were markedly different from those of the relatively smaller spatial scales; large overlaps between the geographical units around the reservoirs occurred at this scale, and may therefore not reflect the situation in the immediate surroundings of the reservoirs.

In terms of the influences of LULC types, change in cropland area was found to be the main factor influencing the direction of anthropogenic index between 2002 and 2014. For instance, expansion in cropland area at the watershed scale during this period accounted for ~90% of SRs that experienced an increase in anthropogenic index. Figure 3 shows how cropland expansion during the period resulted in a corresponding increase in anthropogenic index for the watershed of the Sapouy Reservoir.

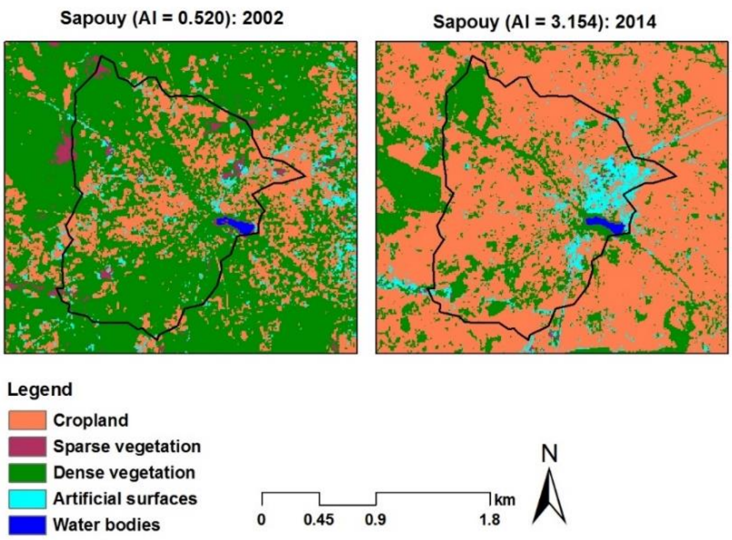

Figure 3: Changes in 2002 and 2014 LULC maps for the Sapouy watershed.

Lessons learned and implications

- Analysis of SRs in Burkina Faso has shown that their numbers have increased over the years up until December 2014, which signify that they are meeting an increasing demand for multiple purposes in Burkina Faso.

- The study has shown that the most influential factor impacting the AI is changes in cropland. This can be considered congruent with the current practice in Burkina Faso of using SRs mostly for cropping. The implication is that uncontrolled expansion of croplands in the region could affect the water quality of SRs, thus requiring stakeholders to plan and properly monitor the use of SRs for cropping.

- Increasing area of artificial surfaces (e.g., settlements, houses), especially in the 5 km buffer area around SRs, also led to high changes in anthropogenic index between 2002 and 2014. This situation highlights the practice of people settling within close proximity to water sources and the potential impact of urbanization on SRs.

Recommendations for future work

- The Landsat images were not useful for detecting SRs with a surface area of less than 1 ha due to its spatial resolution of 30 m. This limitation could imply that the total number of small reservoirs is greater than what was observed in this study. New open access satellite data with high spatial resolution (e.g. 10 - 20 m Sentinel-1 and 2) can be explored to improve the number of detectable SRs. Ultimately, a rigorous validation of the database, e.g. using very high resolution data of selected areas, is required.

- The temporal availability of satellite data affected the accuracy with which the LULC were derived. For example, the use of images acquired during or after harvest resulted in confusion between artificial surfaces and cropland and between different vegetation types. This limitation may have affected the outcome of this study, including the reported changes in anthropogenic index. Improved information on LULC in Burkina Faso is recommended for future work, as is fieldwork to validate the classes that have been used in this study.

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Further reading

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Data sources

Remotely sensed data were the major data sources for the study: Landsat satellite images were downloaded from the global visualization viewer (GLOVIS); gridded population databases were from worldpop (www.worldpop.org.uk); and Shuttle Radar Topographic Mission (SRTM) DEM was downloaded from the CSI (consortium for spatial information) website (http://srtm.csi.cgiar.org/).

Acknowledgments

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