

Research Application Summary

Investigation of the drivers and impacts of agricultural expansions on the Kafue River basin in Zambia's Copperbelt Province and their implications on environmental and social sustainability

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Abstract

Agriculture remains a single largest contributor to deforestation and overall environmental damage in Sub Saharan Africa including Zambia. Subsistence agriculture along the Kafue River Basin in Zambia's Copperbelt province is more pronounced now than before. Despite the significant role that the Kafue River basin plays in sustaining Zambia's economic system, little information is known on the socio-economic effects on riverbank cultivation on communities residing between Kitwe and Chingola in the Copperbelt Province. To address the information gap, this study will be conducted purposely to investigate: the extent to which climate change is driving riverbank cultivation in the Kafue River Basin, what long-term spatiotemporal landscape changes that have occurred overtime on the Kafue River basin, which model of agricultural production system would promote environmental sustainability along river banks; what are the environmental effects of river bank cultivation. The root cause of this problem emanates from the time Government of Zambia (GRZ) began privatisation of the mining sector in 1990 resulting in many Zambians losing employment opportunities, compromising their means of survival living them with limited income opportunities. This forced them to engage in unsustainable agricultural activities encroaching into the Kafue River Basin using fertilisers and pesticides as a way to boost their agricultural productivity. Rural communities also hold vast of indigenous knowledge which ensures for their sustainability which when combined with local knowledge, cutting edge-science and technology in agricultural production increases food security thus sustaining livelihoods. Agricultural expansions that occur over a long time can be monitored using remote sensing (RS) which provides detailed information on land use (LU) and land change (LC) and corresponding changes. Triangulating geographic information systems (GIS) and RS techniques can be combined to analyse spatiotemporal landscape change dynamics.

Key words: Agricultural expansions, Copperbelt, Kafue River Basin, Riverbank cultivation

Résumé

L'agriculture reste le plus grand contributeur à la déforestation et aux dommages environnementaux globaux en Afrique subsaharienne, y compris en Zambie. L'agriculture de subsistance le long du

bassin du fleuve Kafue dans la province du Copperbelt en Zambie est plus prononcée maintenant qu'auparavant. Malgré le rôle significatif que le bassin du fleuve Kafue joue dans le maintien du système économique zambien, peu d'informations sont disponibles sur les effets socio-économiques de la culture en bord de rivière sur les communautés résidant entre Kitwe et Chingola dans la province du Copperbelt. Pour combler cette lacune d'information, cette étude sera menée de manière ciblée pour enquêter sur : dans quelle mesure le changement climatique stimule la culture en bord de rivière dans le bassin du fleuve Kafue, quels sont les changements paysagers spatiotemporels à long terme qui se sont produits au fil du temps dans le bassin du fleuve Kafue, quel modèle de système de production agricole favoriserait la durabilité environnementale le long des rives des rivières ; quels sont les effets environnementaux de la culture en bord de rivière. La cause profonde de ce problème remonte au moment où le gouvernement zambien (GRZ) a commencé la privatisation du secteur minier en 1990, entraînant la perte de nombreuses opportunités d'emploi pour les Zambiens, compromettant leurs moyens de subsistance et les laissant avec des opportunités de revenus limitées. Cela les a forcés à se livrer à des activités agricoles non durables en empiétant sur le bassin du fleuve Kafue en utilisant des engrais et des pesticides comme moyen de stimuler leur productivité agricole. Les communautés rurales détiennent également une vaste connaissance indigène qui assure leur durabilité, laquelle, combinée à la connaissance locale, à la science de pointe et à la technologie dans la production agricole, accroît la sécurité alimentaire, maintenant ainsi les moyens de subsistance. Les expansions agricoles qui se produisent sur une longue période peuvent être surveillées à l'aide de la télédétection (RS), qui fournit des informations détaillées sur l'utilisation des terres (LU) et les changements de terres (LC) et les changements correspondants. La triangulation des systèmes d'information géographique (SIG) et des techniques de télédétection peut être combinée pour analyser les dynamiques de changement paysager spatiotemporel.

Mots-clés : Expansions agricoles, Copperbelt, Bassin du fleuve Kafue, Culture en bord de rivière

Background

In Zambia, agriculture features a distinct contrast between commercial and subsistence farming with subsistence farmers geographically distributed throughout the country and are, in most instances, food insecure. Although the Zambian government has in the recent past been promoting sustainable agricultural production system, its impact towards riverbank cultivation remains questionable. Although Zambia is a signatory to many conventions on environmental management, there has been very little progress made towards attaining environmental sustainability in the agricultural sector. As expected, agriculture remains the single largest contributor to deforestation and overall environmental damage. The unsustainability of the agriculture sector appears to stem from the lack of job opportunities and demeaning domestic incomes especially for communities in rural areas. In mining sites such as in the Copperbelt province, the dismantling and later on sale of the giant mining conglomerate, ZCCM, in the early 1990s, gave rise to unprecedented unemployment levels and poverty (United Nations Development Programme 2016).

The privatisation of the mining sector by the government of Zambia (GRZ) in 1990 resulted in Zambians losing employment opportunities (United Nations Development Programme 2016). Their means of survival were compromised living them with very limited income opportunities. In Copperbelt Province, this saw a noticeable high pressure on the subsistence farmers' ability to sustain their livelihoods. The livelihoods discourse forced households in Copperbelt Province

to engage in unsustainable agricultural activities thereby encroaching into Kafue River basin. Their limited knowledge on the efficient use of natural resources, coupled with climate change in addition to socio-economic and political dynamics further worsened their situation. Not surprising there has been noticeable increase in riverbank cultivation on the Copperbelt following mining privatisation. As expected, marked landscapes changes especially along the banks of the major streams and rivers that feed into the Kafue River have become visible over time. However, the transformations in land use (LU) and land cover (LC) change risk these communities losing the valuable ecological and socio-economic benefits which they can gain from preserving the Kafue Riverbanks. Although agriculture expansion has time and again been linked to riverbank degradation, little is known on the actual mechanisms and long-term trends associated with the environmental sustainability of the Kafue River basin cultivation on the Copperbelt.

Drivers of agricultural expansions

Given the important role that the Kafue River basin plays in sustaining Zambia's economic system, studying the role of agriculture expansion along the Kafue river system will provide the much-needed evidence-based support to policy review and formulation. Consequently, data from this study will help in unravelling the important nexus between unplanned agriculture expansion and the environmental sustainability of a vulnerable river basin. Facing such pressures, sustainable use of Kafue River must be put forward as one of the main solutions for a policy-oriented response by GRZ, thus motivating this study.

Climate change predictions for most sub-tropical regions, point in the direction of decreasing mean annual precipitation (IPCC 2007). In particular, the current climatic prediction for the Miombo ecoregion is for a reduction in mean annual precipitation by more than 20% (Sithole and Murewi 2009). Drought events are therefore, expected to intensify and may lead to drought-induced agriculture-failure. Therefore, to mitigate the potential impacts of climate change many subsistence farmers are likely to migrate towards existing river ecosystems to meet their food needs. It is however, unfortunate fact that the Copperbelt province has one of the highest population growth rate and as expected the increasing population will need more food production (Chimwanza *et al.*, 2006). Expanding agriculture fields towards the river banks has its own consequences of fertiliser and pesticide use as a way of boosting agricultural productivity. Regrettably, these chemicals have tendencies of seeping into the underground water (Chimwanza *et al.*, 2006), thereby compromising its quality and causing health hazards to both subsistence farmers as well as communities downstream. The situation has been worsened by a rapid increase in population translating into an increased demand for human settlement forcing for the unsustainable usage of Kafue Riverbanks without considering its ecological functions and values. If the riverbanks are not protected and continue to degrade, they will cease to recuperate for future generational use. However, the interaction between agriculture expanding into the Kafue River basis and changes in climate changes remains poorly understood.

The study, in part, will investigate the drivers of riverbank cultivation along Kafue riverbank, how agriculture is driving deforestation, the type of crops grown by these communities, who is really involved in riverbank farming, to what extent it is causing soil erosion, siltation and land degradation. The undeterred increase of riverbank cultivation for agricultural expansions in Copperbelt will continue to threaten the environmental wellbeing of a society that relies heavily on the biodiversity and ecosystems, and this has in part motivated this study.

Riverbank cultivation on the upper Kafue river basin raises numerous unanswered questions. To what extent is climate change driving riverbank cultivation in the Kafue River Basin? What are the long-term spatiotemporal landscape changes that have occurred overtime on the Kafue River basin? Which model of agricultural production system would promote environmental sustainability along river banks? What are the environmental effects of river bank cultivation?

Agricultural expansions that occur over a long period can be monitored using Remote Sensing (RS) techniques which provides detailed information on LU, LC and corresponding changes. This study intends to create technical feasibility which will be able to retrieve thematic data on the driving forces of agricultural expansions along Kafue River. Also, the study will analyse the implications this has on livelihoods, food security, and environmental sustainability. The triangulation of GIS and RS techniques will be applied to analyse spatiotemporal landscape change dynamics along the Kafue River in the Kitwe district between the years 1990 to 2025.

Conclusion

Riverbank cultivation along Kafue river basin for agricultural expansions in Copperbelt raises numerous unanswered questions which if not answered will continue to threaten the environmental wellbeing, biodiversity and ecosystems. Agricultural expansions which are occurring along Kafue River banks between Kitwe and Chingola will be monitored using Remote Sensing (RS) techniques in order to provide detailed information on LU and LC which are occurring. By triangulating GIS and RS techniques, the study will analyse spatiotemporal landscape change dynamics along the Kafue River in the Kitwe district between the years 1990 to 2025.

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References

- Chimwanza, B., Mumba, P. P., Moyo, B. H. Z. and Kadewa, W. 2006 The impact of farming on river banks on water quality of the rivers. *International Journal of Environmental Science and Technology* 2 (4): 353-358.
- Fye, L. M. 2006. Privatization in Africa : Agenda World.
- Hansen, M. C., Yaroshenko, A., Esipova, E., Komarova, A., Smith, W., Turubanova, S., Potapov, P., Minnemeyer, S., Thies, C., Laestadius, L. and Zhuravleva, I. 2017 The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013 *Sci. Adv.* 3 e1600821 Online: <http://advances.sciencemag.org/>
- IPCC. 2007 Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
- Jayne, T. S., Chamberlin, J. and Headey, D. D. 2014 Land pressures, the evolution of farming systems, and development strategies in Africa. A synthesis. *Food Policy* 48 1–17 Online: <http://dx.doi.org/10.1016/j.foodpol.2014.05.014>
- Omkar, S. N., Senthilnath, J., Mudigere, D. and Manoj Kumar, M. 2008. Crop classification using biologically-inspired techniques with high resolution satellite image. *J. Indian Soc. Remote Sens.* 36 175–82

- Sithole, A. and Murewi, C.T. 2009. Climate variability and change over southern Africa: impacts and challenges. *African Journal of Ecology* 47: 7-20.
- Treitz, P. and Rogan, J. 2004. Remote sensing for mapping and monitoring land-cover and land-use change-an introduction. *Progress in Planning* 61 (4): 69-279.
- United Nations Development Programme U. 2016 Zambia Human Development Report 2016 United Nations Dev. Program.
- Wulder, M. A., White, J. C., Nelson, R. F., Næsset, E., Ørka, H. O., Coops, N. C., Hilker, T., Bater, C. W. and Gobakken, T. 2012 Lidar sampling for large-area forest characterization: A review . *Remote Sens. Environ.* 121: 196–209. Online: <http://dx.doi.org/10.1016/j.rse.2012.02.001>