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Publication date
2022

Document Version
Final published version

Published in
Anthropogenic Rivers: Book of Abstracts NCR DAYS 2022 13-14 April | TU Delft

Anthropogenic Rivers

Book of Abstracts

NCR DAYS 2022

13-14 April | TU Delft

Astrid Blom, Laura M. Stancanelli, Jelle A. Dercksen, Clàudia Ylla Arbós, M. Kifayath Chowdhury, Shelby M. Ahrendt, Carolina Piccoli, Ralph M.J. Schielen, Kees Sloff & Jill H. Slinger (eds.)

NCR Publication: 49-2022

Netherlands Centre for River studies NCR

Modelling both local and national effects of construction and operation of the Pwalugu Multipurpose Dam

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Keywords — Dam Operation, Flood-Recession Agriculture, Riparian Communities, System Dynamics

Introduction

Dam construction and operation tend to put more focus on the national benefits while disregarding the effects the dam can have on local communities Darko et al. (2019). The construction of the Pwalugu Multipurpose Dam (PMD) in Northern Ghana would be no exception to this. The dam, mainly used for flood mitigation, irrigation and electricity generation, could affect the flow of the White Volta river in such a way that the Ecosystem-based Activities (EBA) effectively of the riparian communities could not be performed anymore Mul et al. (2017). These EBAs include farming, riparian pond fishing and livestock watering Mul et al. (2017). However, the riparian communities will also benefit from the construction of the PMD as they will become less prone to floods caused by high spillage at the upstream Bagre Dam Gonzalez et al. (2021).

Many of studies have been done on dam operations and the accompanying effects on the flow of the river. However, these studies have a propensity to underestimate the effects the dam will have on the local communities or simply suggest displacing the local communities Darko et al. (2019). This thesis research will not only build a System Dynamics (SD) model that aims to give insight into how the construction and operation of the PMD will affect the riparian communities, but it will also try to quantify these effects. The modeling of the EBAs of the riparian communities, like flood-recession farming, is a complex task which has not been done often in studies on previously constructed dams. Therefore the aim is to model the effects the construction and operation of the PMD has on the EBAs of the riparian communities, in such a way that the model and approach can be applied to other future dam constructions.

System Dynamics approach

This research applies a System Dynamics approach to model the effects of the construction and operation of the PMD. System Dynamics does not only help quantifying the effects of the PMD but also makes it possible to add seasonality, which has not yet been possible in ordinary Environmental Impact Assessments eg: Volta River Authority (2014). This seasonality is an important part of the system as the EBAs of the riparian communities are heavily dependent on the seasonality of the river. Moreover the White Volta River system and all the dams operating on it are suitable for SD as there are multiple stock and flows within the system as well as feedback loops and delays Nabavi et al. (2017) as can be seen in figure 1 underneath.

Direction of Results

As this thesis research is still in the early stages and the SD model is still under construction, there are no final results just yet. However, from available literature and the current behaviour of the model preliminary results are available. The construction of the PMD will probably cause the base flow of the White Volta river to increase, which is what the Bagre Dam further upstream did too. Moreover, it will reduce the number of floods experienced by the riparian communities as the dam adds another buffer to the system. The presence of the PMD will also affect the filling of the riparian flood plains and ponds, which are used for farming and fishing, less water here could lead to less arable farmland and less fish, however how significant this effect will be can't be stated yet.

Nevertheless, it is already clear that policy makers will have to make trade-offs between electricity generation at the PMD and operating strategies that support the local communities more. This research hopes to find a dam operating strategy that would not only be a national but also a local success.

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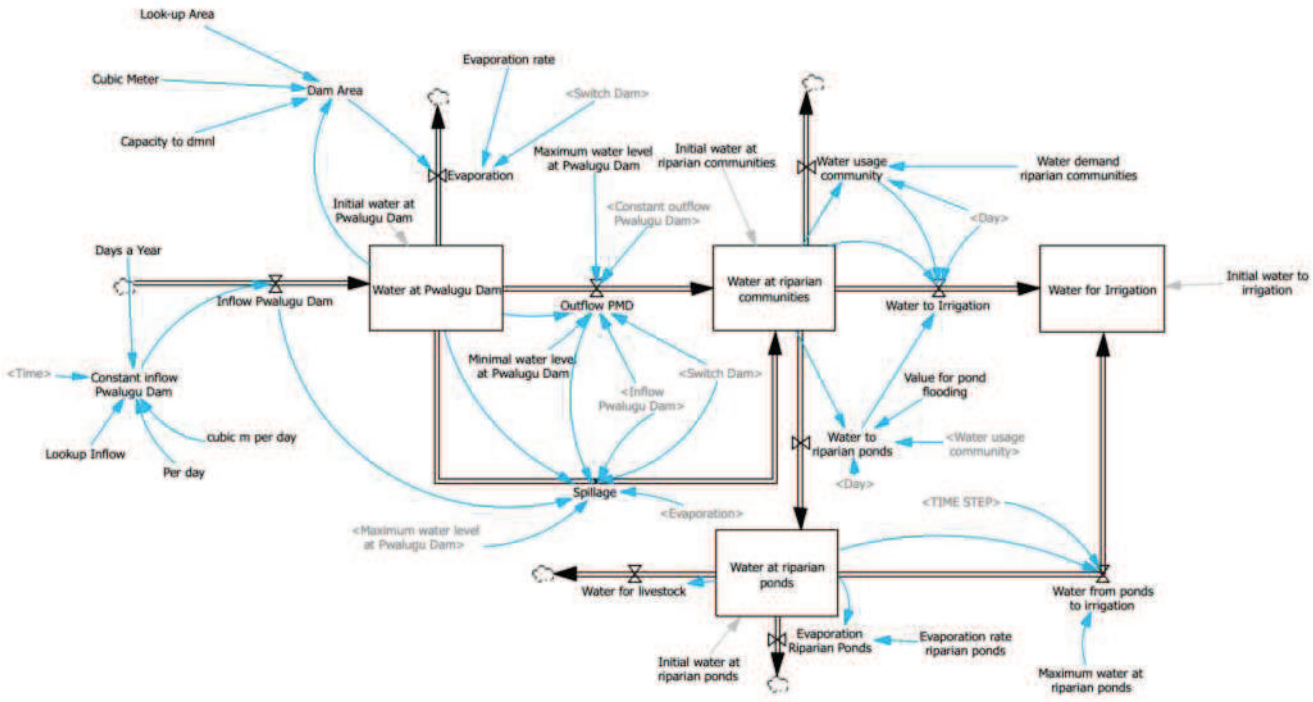

Figure 1: A simplified version of the System Dynamics model that will be constructed for this thesis research. It can be seen that water at the different locations can be considered stocks while the stocks are connected with flows which in this case is the White Volta River.