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ScienceDirect

Energy Procedia 97 (2016) 286 – 293

Energy Procedia

European Geosciences Union General Assembly 2016, EGU
Division Energy, Resources & Environment, ERE

Regional assessment of the hydropower potential of rivers in West Africa

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Abstract

In this study the theoretical hydropower potential of all rivers in West Africa was assessed. The study domain covers 5 Mio km². For more than 500,000 river reaches the theoretical hydropower potential was computed from channel slope and mean annual discharge simulated by a water balance model. The model was calibrated with observed discharge at 410 gauges, using precipitation and potential evapotranspiration data as inputs. Possible changes in future discharge were assessed by driving the water balance model with climate projections of 15 Regional Climate Models for two emission scenarios of the CORDEX-Africa ensemble.

Peer-review under responsibility of the organizing committee of the General Assembly of the European Geosciences Union (EGU)

Keywords: hydropower potential, West Africa, water balance modelling, climate change, CORDEX-Africa

1. Introduction

The 15 countries of the Economic Community of West African States (ECOWAS) face a constant shortage of energy supply, which limits economic growth. Currently there are about 50 operational hydropower plants and 40 more are under construction or refurbishment. The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) was created to promote the development of sustainable energy generation including wind, solar and

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Peer-review under responsibility of the organizing committee of the General Assembly of the European Geosciences Union (EGU)
doi:10.1016/j.egypro.2016.10.002

hydro. The potential for future hydropower development – especially for small-scale plants in rural areas – is assumed to be large, but exact data are missing.

The objective of this study is to support the energy initiatives of ECREEE by assessing the theoretical hydropower potential of all rivers in West Africa. This assessment is not limited to large rivers, but also focuses on small rivers for small-scale hydropower development.

The hydropower potential of a river depends on channel slope and mean annual discharge. Channel slope can be computed from digital elevation models with Geographic Information Systems (GIS). However, in large areas there is a lack of discharge observations. Therefore, in this study an annual water balance model was applied to simulate discharge. As hydropower plants are investments with a lifetime of several decades we also assessed possible changes in future discharge due to climate change.

The paper is structured as follows:

- Study area and data basis
- Water balance modelling
- Climate change impact assessment
- Theoretical hydropower potential
- Conclusions and outlook

2. Study area and data basis

This study focusses on all river basins in the 15 countries of ECOWAS in West Africa (Fig. 1). The climate ranges from tropical humid near the Gulf of Guinea to arid in the Sahara in the north. The study area covers about 5 Mio km² including 500,000 river reaches. Major river basins include Niger, Volta, and Senegal.

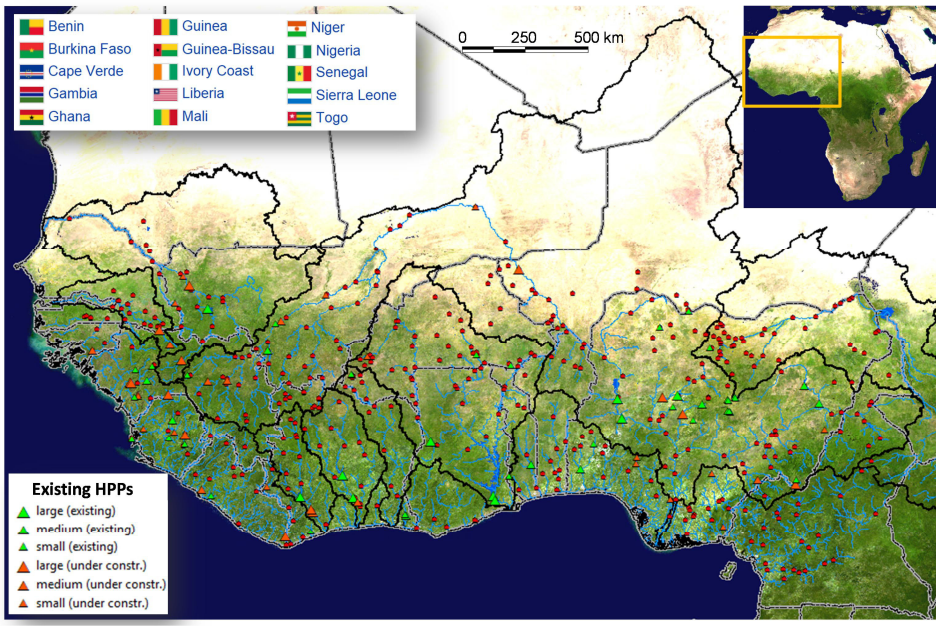

Fig. 1. Study area in West Africa. Blue lines: major rivers. Black lines: major basin divides. Grey lines: Country borders. Red circles: used gauges. Coloured background: satellite image showing vegetated areas in green. Triangles: Existing hydropower plants (HPP) with classification according to installed capacity: small (1-30 MW), medium (30-100 MW), large (> 100 MW).