Consequences of future dams in the Amazon for hydropower production and ecosytems

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Background

Hydropower is the main source of energy for the Amazonian countries, and in particular Brazil. The energy consumption in this region has been increasing by almost 40% between 1999 to 2009 (EIA, 2009). Because a further increase in energy demand is foreseen and the hydropower potential of the water abundant Amazon seems to be inexhaustible, major investments in new hydropower generation structures are planned (figure 1), especially in the western and south eastern parts of the basin.

It is however unclear how changes in climate and landuse will affect the hydrological patterns, and therefore the potential energy production of all these planned structures. Moreover, there is a need to systematically assess the potentially negative effects of those structures on both people and ecosystems.

Objective

- To assess the impact of climate change and land use change on the production capacity of operational and planned hydropower plants.
- To evaluate the potential impacts of operational and planned hydropower plants on downstream ecosystems and ecosystem services

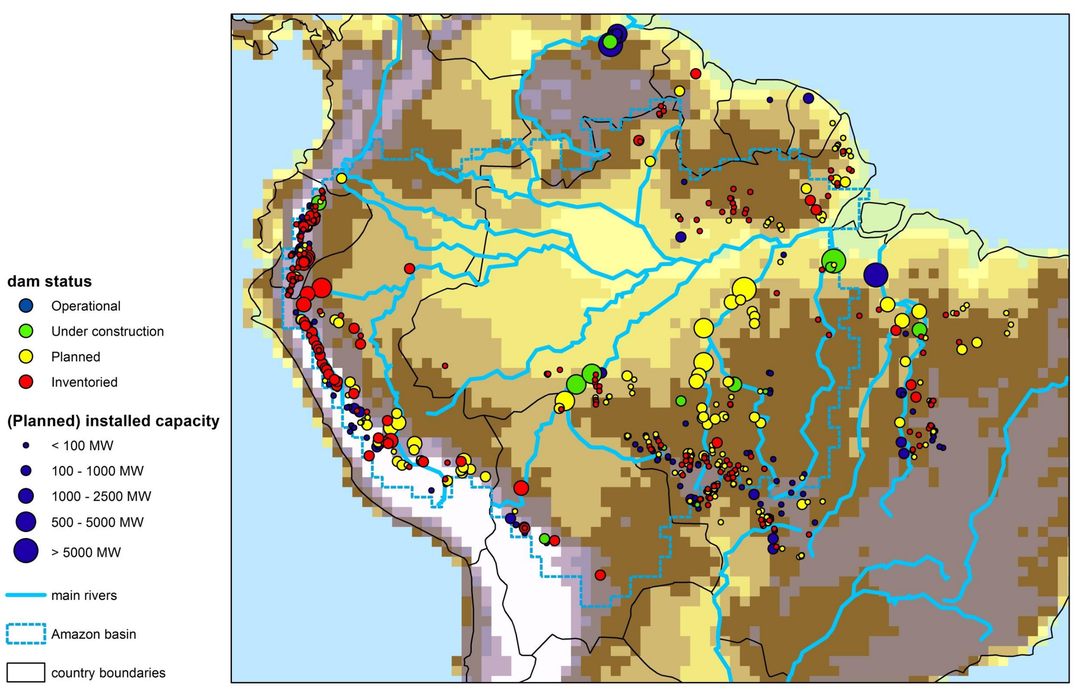

Figure 1. Locations, installed capacity and status of planned dams in the Amazon basin. Source: Dams in Amazonia Database, International Rivers, www.dams-info.org

Method

We used the global vegetation and hydrology model LPJmL (Rost et al, 2008) to calculate the effects of climate change and land use change on the future hydrology of the Amazon (figure 2). A baseline was created by driving LPJmL with observed climate (Sheffield et al, 2006), under potential natural vegetation. Subsequently, the model was driven with climate scenarios from 3 global climate models for the AR4 SRES A2 scenario combined with 3 land-use scenarios, representing different levels of deforestation (Aguiar et al, 2012). We analysed projected changes in mean annual flow at the locations of operational and planned hydropower generation plants (figure 3). Finally, we implemented all planned hydropower dams in the reservoir module of LPJmL (Biemans et al., 2011) and made a first estimate of the extend of downstream impacts of those dams (figure 4).

Results

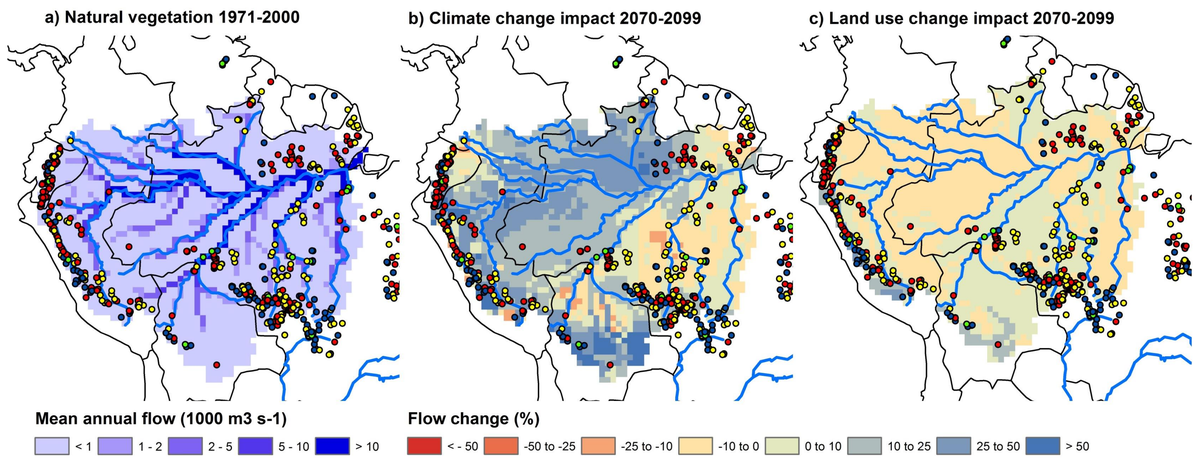

Figure 2 a) Mean annual flow calculated by LPJmL forced with observed climate data (Sheffield et al., 2006) with potential natural vegetation. **b)** projected changes in mean flow for 2071–2100 relative to 1971–2000 averaged for three GCMs (HadCM3, PCM and CCSM) for the SRES A2 emissions scenario, with potential natural vegetation, and **c)** projected changes in mean flow due to land use scenario C2 (extreme deforestation) relative to potential natural vegetation. Dots represent locations of operational and planned dams.

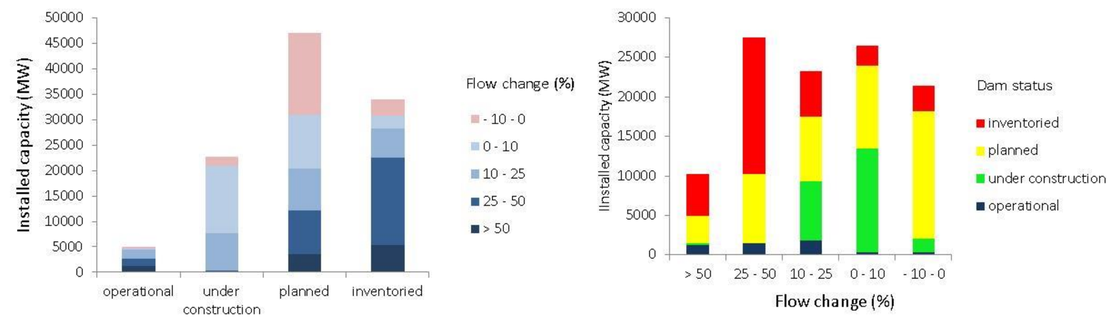

Figure 3 Total operational and planned installed capacity with projected changes in mean annual flow for 2071-2100 relative to 1971-2000.

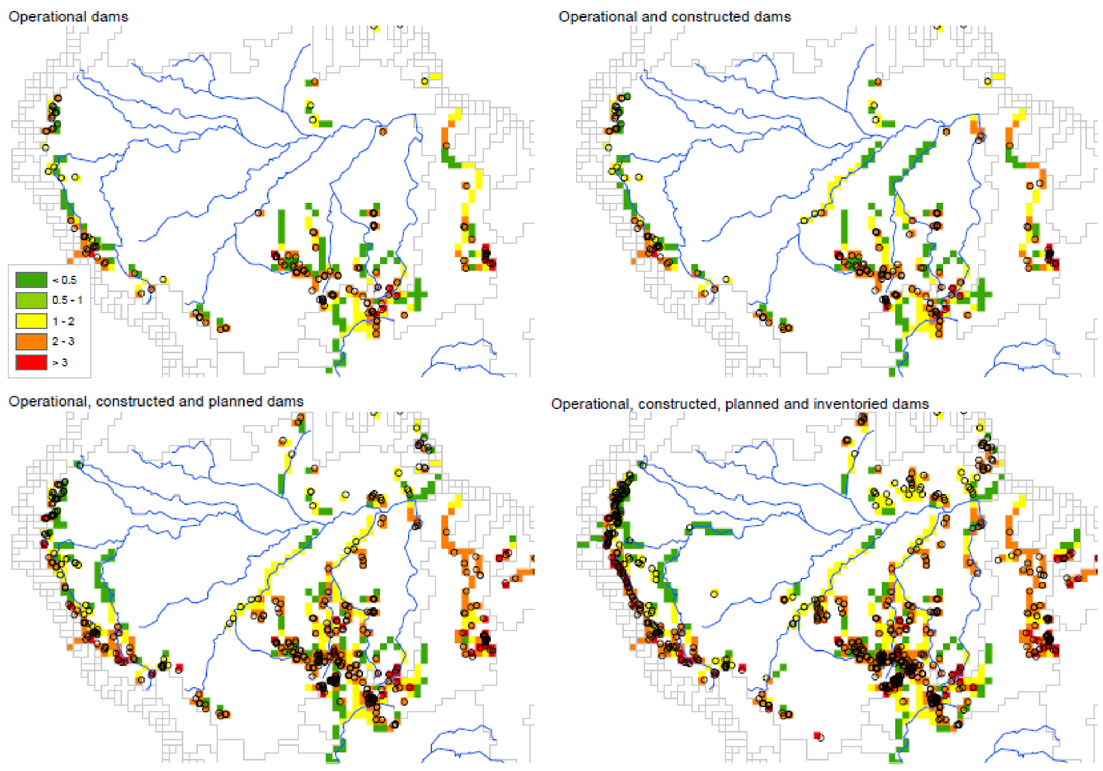

Figure 4 Downstream effects of flow regulations by hydropower dams expressed by the annual proportional flow deviation (AAPFD). The AAPFD is an indicator for the modification level of a river system compared to natural conditions.

Conclusions

- Increases in mean annual flow are projected for the majority of locations with existing and planned hydropower constructions.
- Further study is needed to evaluate effects of changes in both intra- and inter-annual variability on hydropower potential.
- River flows patterns will be affected far downstream of the dams.
- Further study is needed to understand effect of dams on aquatic ecosystems and downstream inundation patterns.

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