Climate knowledge and hydropower in Latin America

Sebastian Vicuña

Centro Interdisciplinario de Cambio Global,
Pontificia Universidad Católica de Chile

Hydropower is the main source of renewable energy available in Central and South America. These regions are only second to Asia in terms hydropower based electricity generation in the world, displaying a 20% share of total annual generation (SRREN report IPCC, 2011). The quality of water resources availability is the largest in the world with an average regional capacity factor of over 50%. As a result, the region has by far the largest proportion of electricity generated through hydropower facilities. On average Latin America has more than 60% of electricity provided by hydropower facilities in contrast to a less than 20% for the world (IEA, 2012). Considering some specific countries in the region it can be seen that in general hydropower proportion of total electricity production is over 40% and in some cases is near or close to 80% (Brazil and Costa Rica for example).

The linkages between climate and hydropower are many and reflect the feedback mechanisms that affect the water energy climate nexus. On one hand, although greenhouse gas (GHG) emissions can be significant depending on the type of hydropower system and location, this type of electricity generation is seen a major contributor to mitigating GHG emissions worldwide (IPCC, 2011).

On the other hand hydropower relies on water, a resource obviously closely related to climate; thus it is likely to suffer from the potential impacts of climate variability and climate change. Methods designed to better handle climate variability and uncertainty in the operation of hydropower systems or combined thermal and hydropower systems have been developed since the early years of water resources engineering research. Despite the increased sophistication in the scale and details of the hydropower development or operational problems trying to be solved as can be seen in examples such as Grygier and Stedinger (1985), most of this work relied on the promise that climate has stationary statistical properties. However, as pointed out by Milly et al. (2008) this stationarity might be dead (if not dead already) due to climate change. This has profound consequences in the way hydropower systems are both operated or developed in the case new ones are considered. In Chile for example the two largest hydropower systems (Maule and Laja) are operated (in conjunction with other type of users such as agriculture) using hydrologic (and hence climate) information that could be 30 or even 50 years old. If the climate deviates significantly from these conditions there could be potential stresses in already water tight systems. Examples of the potential impacts of climate change on hydropower systems (and consequences in overall electricity systems) have been developed for different systems in the region such as the Lempa basin in Central America (Maurer et al., 2009), the Maule and Laja basins in Chile (ECLAC, 2009, McPhee et al. 2010), and several basins in Brazil (Lucena et al., 2009) among others. However there is still little research on how to incorporate this knowledge in the way these systems should be operated under this new conditions. Of special concern are those mountainous whose hydrologic regime could be altered not only due to changes in precipitation but also due to changes in temperature and radiation as can be expected in snowmelt and glaciated basins of central and southern Andes. There is also no consideration on the assessment of new hydropower projects of the type of legal operation these systems should have in the future again if climate changes (CADE, 2011; Vicuna and Meza, 2012). The complexities associated with climate change in this regards have to be coupled with other type of drivers (physical, legal and cultural) that could change the expected operation of these systems in the future. This is a clear need for new climate knowledge.

Finally, when considering the positive attributes of hydropower generation, aside from its lower operational cost, an always recognized beneficial characteristic of this form of electricity generation is the capacity these systems (especially those with storage capacity) have to quickly respond to sudden increases in electricity demand. In California for example the percentage of hydropower installed capacity is relatively low compared to natural gas or nuclear power. However hydropower plants play a crucial role of meeting peak hot summer-air conditioning driven-electricity demand (Vicuna et al., 2012). The large increase of, in some cases, unpredictable, and highly variable renewable energy (e.g. wind power) was unintentionally augmented this ancillary benefit of hydropower generation. When wind power is not available backup is needed to supply electricity demand. Starting a gas or coal fired power plant takes much longer than opening the valves of a hydropower system and hence hydropower could play a significant role in stabilizing this new heavily based non-conventional renewable energy (NCRE) power grid needed to reduce GHG emissions to the atmosphere. Electricity grids of these kinds, with wind farms (or other forms of NCRE) contributing potentially to 20 or 30% of total installed capacity should be operated dramatically different from current conditions. Short term climate forecasts (e.g. wind forecasts) would be extremely relevant to guarantee the stability and low cost operation conditions of these systems. Again this represents another clear need for climate knowledge.

The future of hydropower development in Latin America suffers many challenges in the future such as those related to environmental impacts associated with new projects. The development of new climate knowledge will be critical to overcome some of these challenges in this new water energy climate coupled world.

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