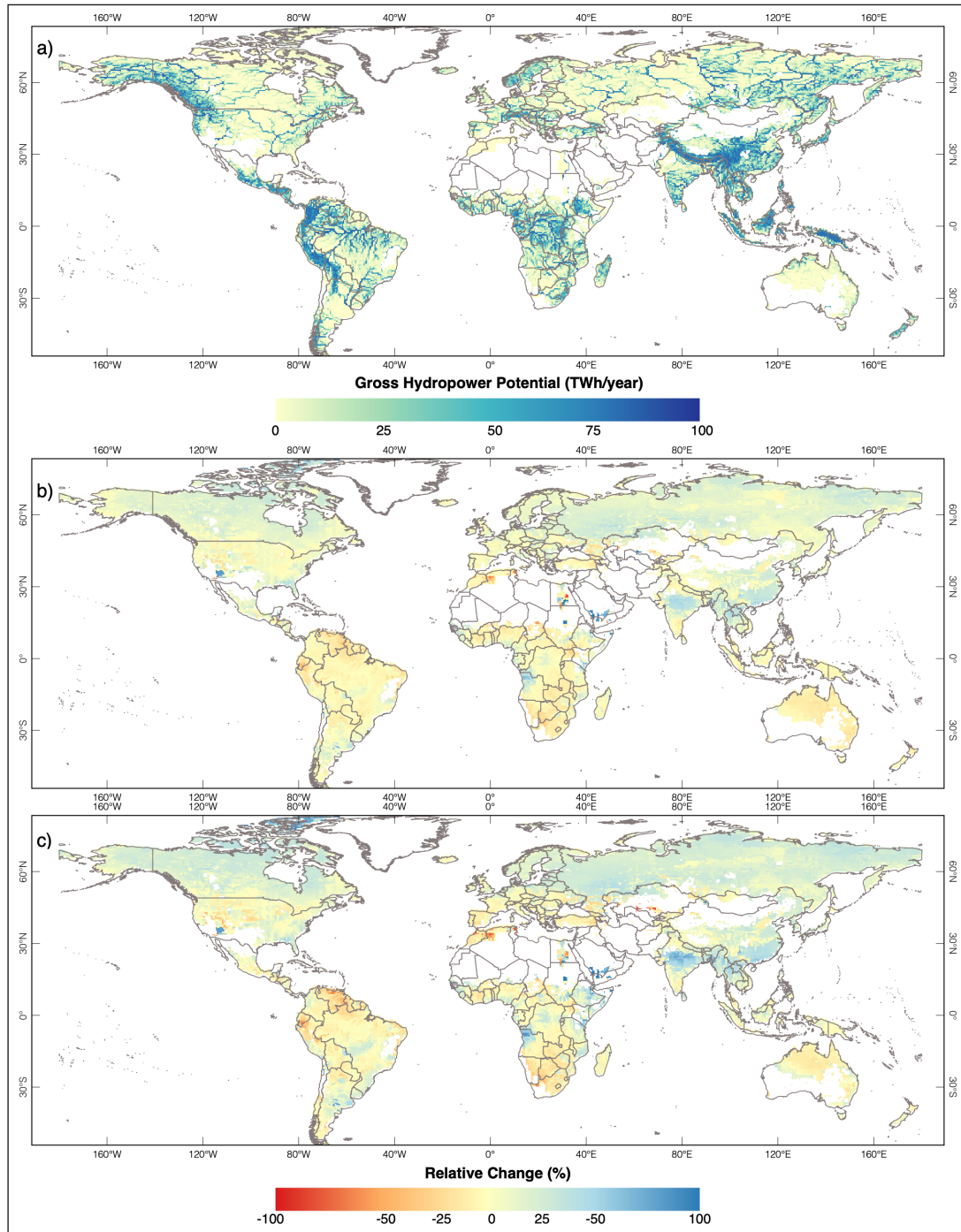


Supplementary 1 – Dams where their reservoirs span over 5 or more grids. Names and capacities obtained from [Lehner *et al.*, 2011]

Reservoir Name	Dam Name	Number of Grids	Capacity (MCM)
Baikal	Irkutsk	18	46000
Three Gorges Reservoir	Three Gorges Dam	16	39300
Lake Winnipeg	Jenpeg	12	31790
Lake Sakakawea	Garrison Dam	12	30220
Repressa de Jupia	Ilha Solteira	10	21170
Sayano-Shushenskoye	Sayano-Shushenskaya	9	31300
Kureiskaya	Kureiskaya	9	9900
Kakhovskoye	Kakhovskaya	8	18180
Lake Onega	Verkhne-Svirskaya	8	17500
Imandra	Kumskaya	8	10800
	Longtan	7	29920
Kinbasket	Mica	7	25000
Sao Simao Reservoir	Sao Simao	7	12540
	Verkhne-Tulomskaya	7	11520
Kovdozero	Tulomskaya	7	11520
Diefenbaker	Gardiner	7	9870
Votkinskoye	Votkinsk	7	9400
Kentucky Lake	Kentucky	7	7560
	Kolyma	7	1460
	Nuozhadu	6	23703
La Grande 4	La Grande 4	6	19530
	Xiaowan	6	15043
Pipmuacan	Bersimis	6	13900
	Xilodu	6	12914
Saratov Reservoir	Saratov	6	12900
Gouin	Gouin	6	8573
	Touloustouc	6	2798
	Kelsey	6	1850
	Uglich	6	1240
Serra da Mesa Reservoir	Serra da Mesa	5	54400
Lake Mead	Hoover	5	36700
Itaipu	Itaipu	5	29000
Ossokamanuan Reservoir	Gabbro Control Dam	5	17676.9
Kainji	Kainji	5	15000
Tres Irmaos Reservoir	Tres Irmaos	5	13450
	Piedra del Aguila	5	12400
Agua Vermelha Reservoir	Agua Vermelha	5	11100
	Son La	5	9260
Opinaca	Opinaca	5	8490
Lake Cumberland	Wolf Creek	5	7510.7
Promissao Reservoir	Promissao	5	7408
	Sheksna	5	6500
Franklin D. Roosevelt	Grand Coulee	5	6395.6
	Estreito	5	5400
Revelstoke	Revelstoke	5	5180
Ijsselmeer	Afsluitdijk	5	5120
Jebel Aulia Reservoir	Jebel Aulia	5	3500
Lake Barkley	Barkley Dam	5	2568.1
	Plain Diversion		
Grand Lake	Dam	5	1790
Lokan Terkojarvi	Lokka	5	1460
	Pavlovskaya	5	1410
Cabonga	Cabonga	5	1300.5

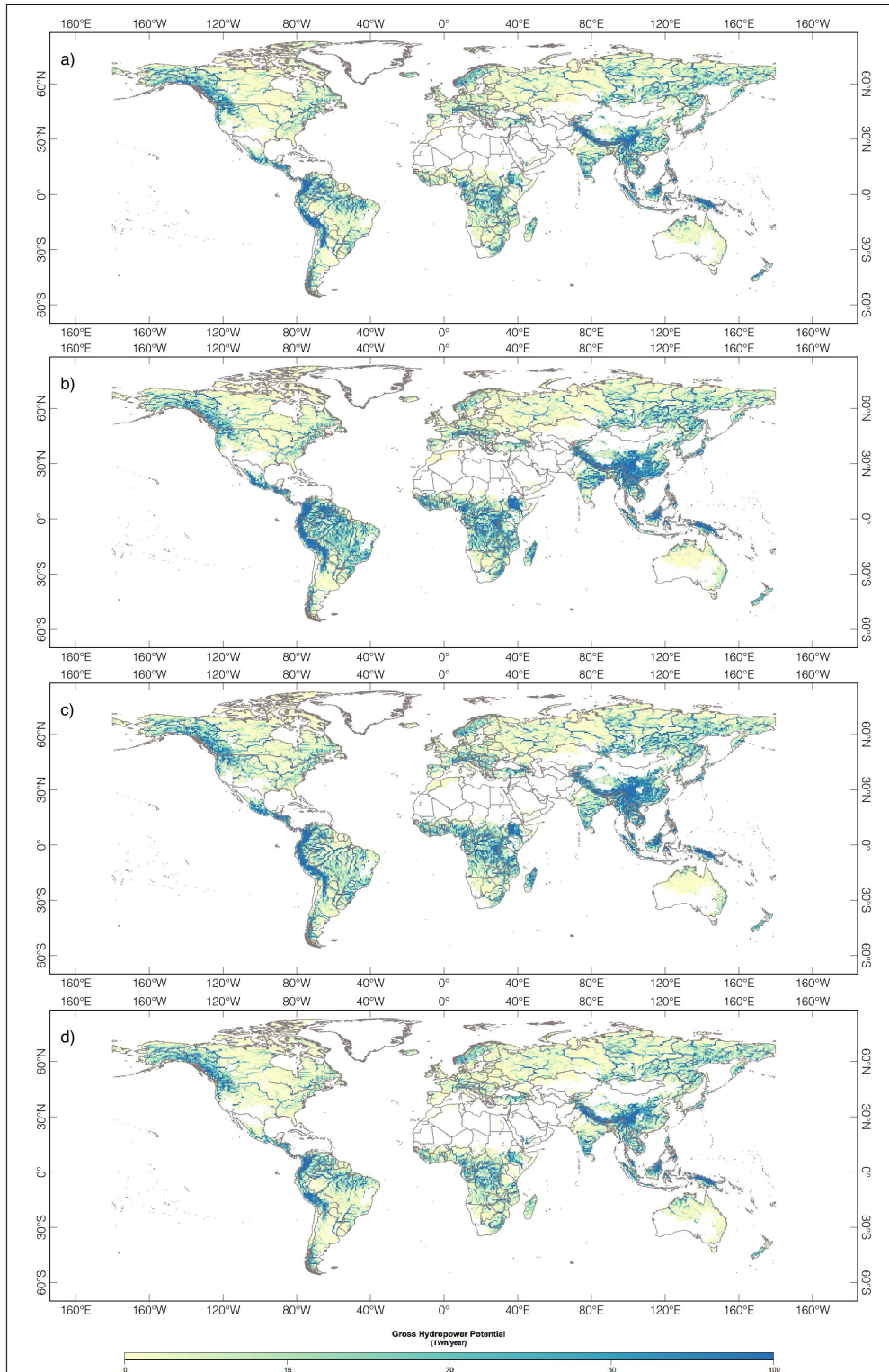
Supplementary Figure 2 – Gross Hydropower Potential

Our multi-model ensemble data estimate for the current mean global GHP is 61.40PWh/year (standard deviation of 16.40 PWh/year). This calculation falls within the ranges that recent studies have estimated between 41 and 67 PWh/year [*Bartle*, 2002; *Pokhrel et al.*, 2008; *Van Vliet et al.*, 2016; *Hoes et al.*, 2017] (note that one study proposes global GHP at 128 PWh/year [*Zhou et al.*, 2015]). The difference across estimates is typically linked with the type of elevation information used, the runoff and river flow used as input, and the grid size which determines heights. In our case the relatively high values may be given by the possible overestimation of the flows used here which is particularly reflected in South Asia [*Paltan et al.*, 2018]. Spatially, GHP is important in areas that traditionally have been highlighted for their hydropower potential such as Asia or areas of the Amazon catchment (Supplementary Figure 1a). Also, we find the spatial distribution of GHP does not vary significantly across the four models used in our study (see Supplementary Figure 2). Yet, the wettest models - MIROC5 and Can-AM4 - show major GHP increases in South America, South Asia, and central-east Africa. For these two models, mean global GHP is 79.16 PWh/year and 73.30 PWh/year respectively.



Supplementary Figure 2. Global Gross Hydropower Potential (GHP), current situation and projected relative changes resulting from the Paris Agreement. a) Multi-model and ensemble annual mean for four AGCMs of the current (from the baseline 2006-2016) GHP estimate, b) Relative change of historical GHP at a 1.5 °C scenario, c) Relative change of historical GHP at 2.0°C. Grid cells where mean daily river flows are $<10\text{m}^3/\text{s}$ were screened out.

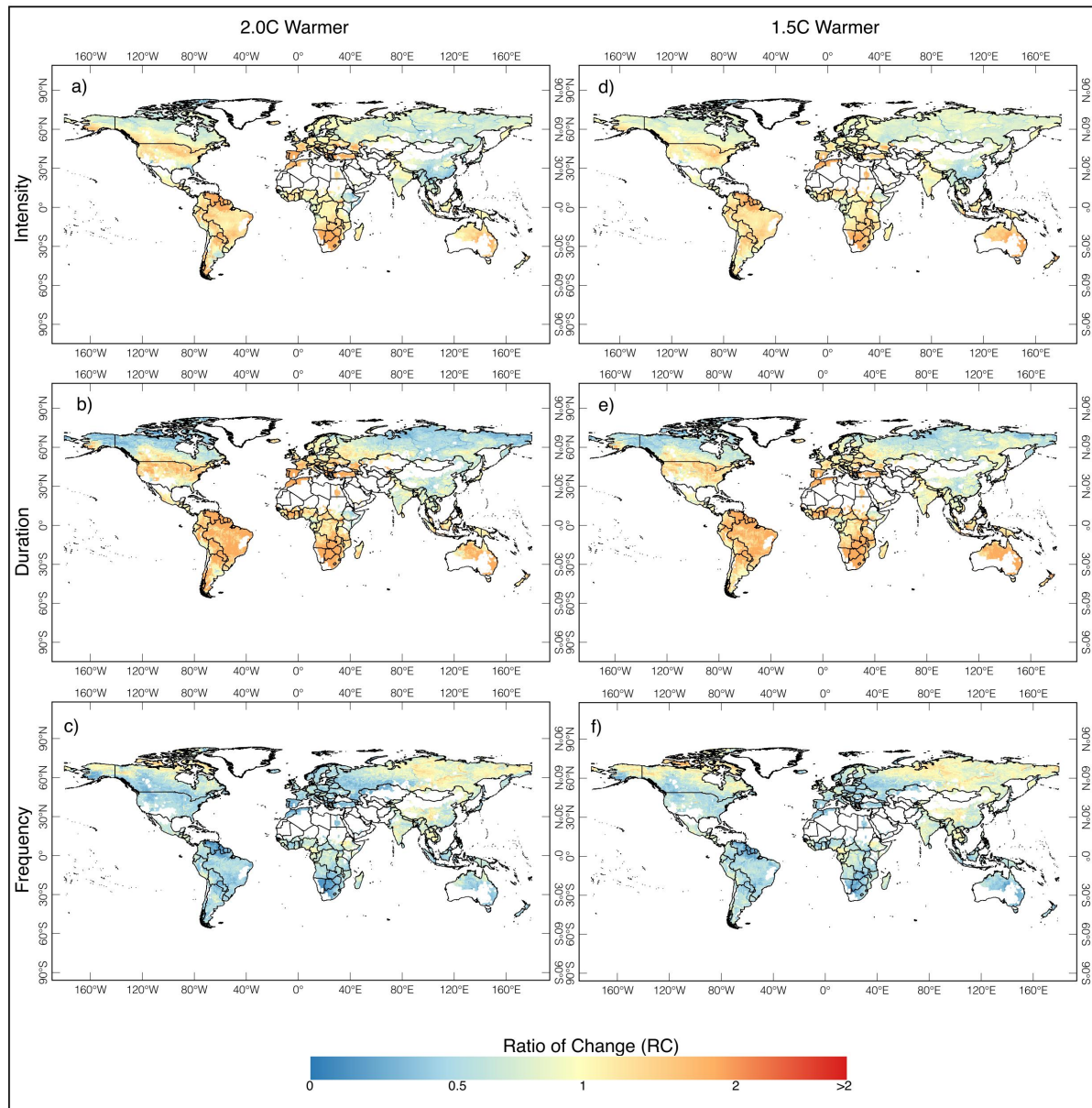
Supplementary Figure 3



Supplementary Figure 3. Multi-ensemble mean of Current Gross Hydropower Potential (GHP), from the baseline 2006-2016: a) Model NorESM1-HAPPI, b) Model MIROC5, c) Model Can-AM4 and d) Model CAM4-2degree

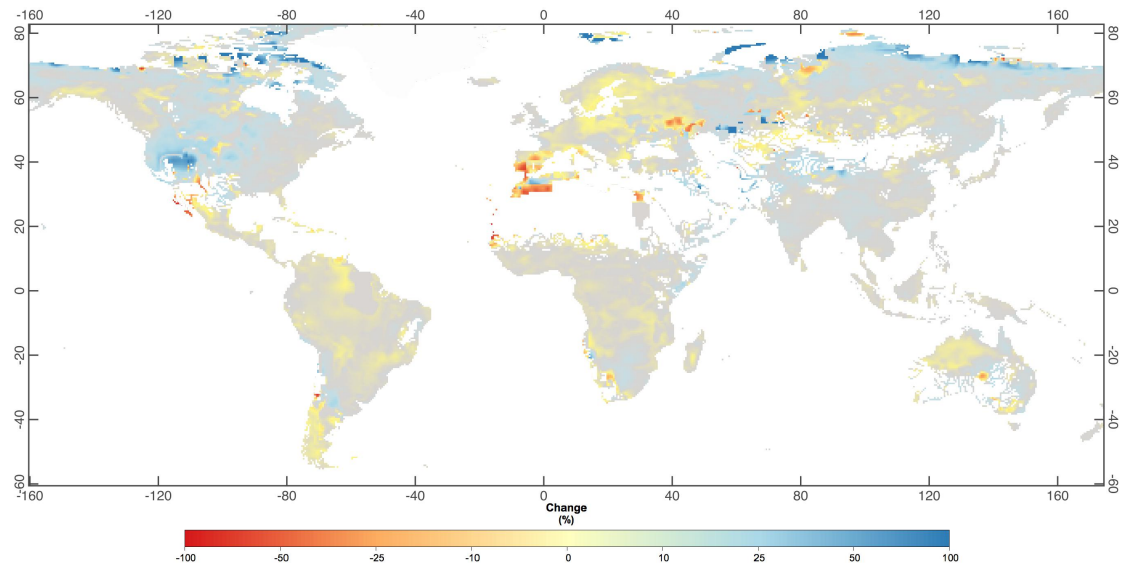
Supplementary Figure 4

Change in droughts characteristics of worlds 1.5C and 2.0C warmer (when compared to the historical).



Supplementary Figure 4. Multi-model ensemble mean of Ratio of Change (RC) of: intensity, frequency, and duration of droughts at worlds 2.0 °C and 1.5 °C warmer ones when compared to their historical baseline (2006-2016). A ratio of change is obtained by following Equation 1. $RC > 1$ indicate that the given drought indicator intensifies at 2.0 oC whereas $RC < 1$ means that such indicators smooths at such climate threshold. Ratios = 1 indicate that there is no future change in such indicator.

Supplementary Figure 5



Supplementary Figure 5. Multi-model median change (%) in the number of days with precipitation between the 1.5C and 2.0C scenario. We define a day with precipitation as that where estimated daily precipitation is greater than 2 mm/day. This threshold is selected as it adequately describes the range of global light precipitation (0.1 – 5mm/day) (Qiaohong et al. 2017).

Supplementary 6 - Variability of hydrological droughts at 1.5 and 2°C warming scenario

Our results indicate that in spite of the fact that globally the frequency of droughts decreases (or does not change significantly) under a 2.0 °C warming scenario when compared with a 1.5 °C scenario, drought intensities and durations of them tend to increase in most regions of the globe (Supplementary Figure 2). Globally, the Ratio of Change (RC) of number of droughts slightly decreases on average to 0.65 at 1.5°C and to 0.60 at 2.0°C. This is possibly explained by the negligible change or increase in the number of days with precipitation found between the two climate scenarios in various global regions (Supplementary Figure 3) including West-central North America and Siberia. It is important to note that regions with a notable decrease in the number of rain days include the Mediterranean region, central and northern Europe, various areas in South America, and Australia. Moreover, at 1.5°C the duration of droughts increases and at 2.0°C drought duration increases yet further (RC from 1.26 to 1.30). Also, the water deficit resulting from drought changes only negligibly at 1.5°C (RC=0.98), whereas at 2.0 °C this value increases to 1.28.

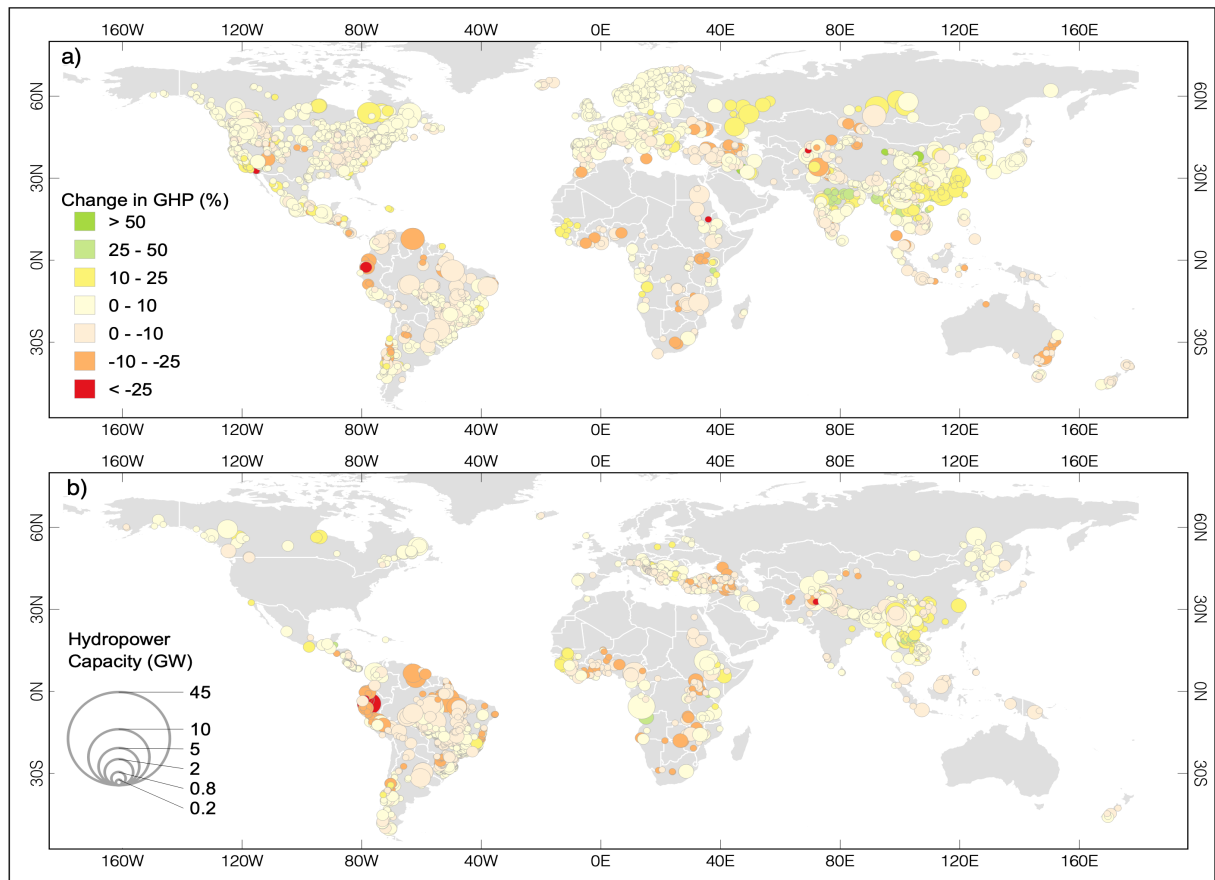
The regions where a 2.0 °C warming scenario would lead to fewer droughts, yet more severe and longer ones, include the U.S West Coast, central-north South America, the Iberian Peninsula, Central Europe, Southern Africa, the area surrounding the Black Sea in Western Asia, and Central China. In these areas the RC of water deficits of droughts between the two climate scenarios typically ranges 1.1 and 1.6, where the highest values are observed in the Iberian Peninsula. Moreover, in Southern Africa and the Iberian Peninsula, the duration of droughts is expected to increase by a factor of two at 2.0 °C. Also, in North Africa, while water deficits and number of droughts decrease at 2.0 °C when compared to a 1.5 °C scenario, their duration importantly prolongs (RC ~2.5). These results suggest that in these regions committing to the 1.5 °C target becomes relevant to attenuate the risks stemming from prolonged droughts.

Also, most of these regions already show the strength of these drought indicators when comparing a 1.5°C warmer world to historical conditions (See Supplementary Figure 2). In areas such Australia or India, the more relevant shift in hydrological droughts occurs already when achieving the 1.5°C target. For instance, Australia shows a decrease in the projected frequency of droughts while showing an increase in the duration and water deficits of them

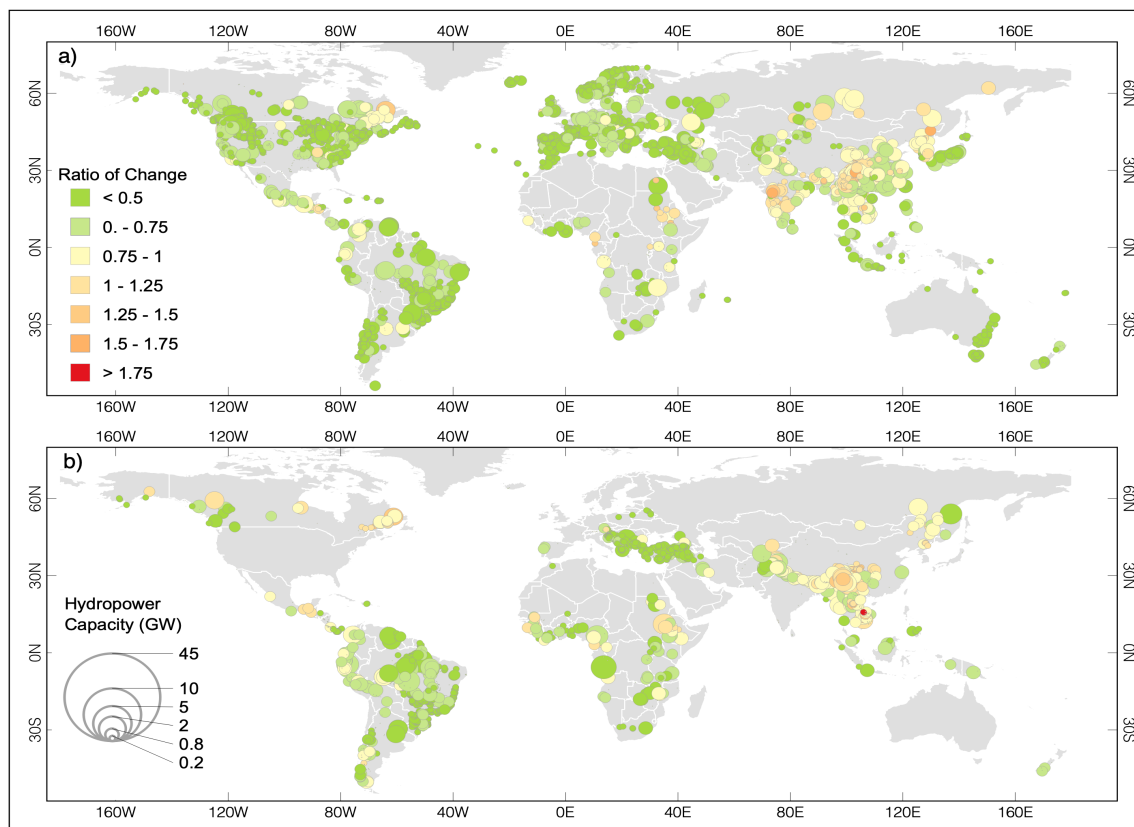
(water deficits RCs ~ 1.8 and 2.2 at 1.5°C and negligible at 2.0°C). In regions such as Southern Africa or the Iberian Peninsula, mentioned above, the RC at 1.5°C is typically 1.5 - 2.5 .

Nonetheless, in other regions of the world, such as Siberia and South and East Asia, we find that by reaching a 1.5°C target, and then a 2.0°C , the frequency, duration and water deficits of droughts decrease or do not change significantly. This may be associated with the important increase in both flow rates and high flow frequencies previously projected for these regions at 1.5°C which have been linked with the reduction in the aerosols load represented by the HAPPI experiment, particularly in the South and East of Asia [*Paltan et al.*, 2018]. For example, mean flow rates at the Ganges and Ob' basins are expected to increase between 5 and 7% at a 2.0°C warming scenario. Likewise, previous studies have also detected that reaching 2.0°C may lead to limited water availability and an increase in the number of consecutive dry days and thus intensifying drought risk in areas such as the Amazon area, South Africa, and in the Mediterranean basin [*Schleussner et al.*, 2016; *Lehner et al.*, 2017].

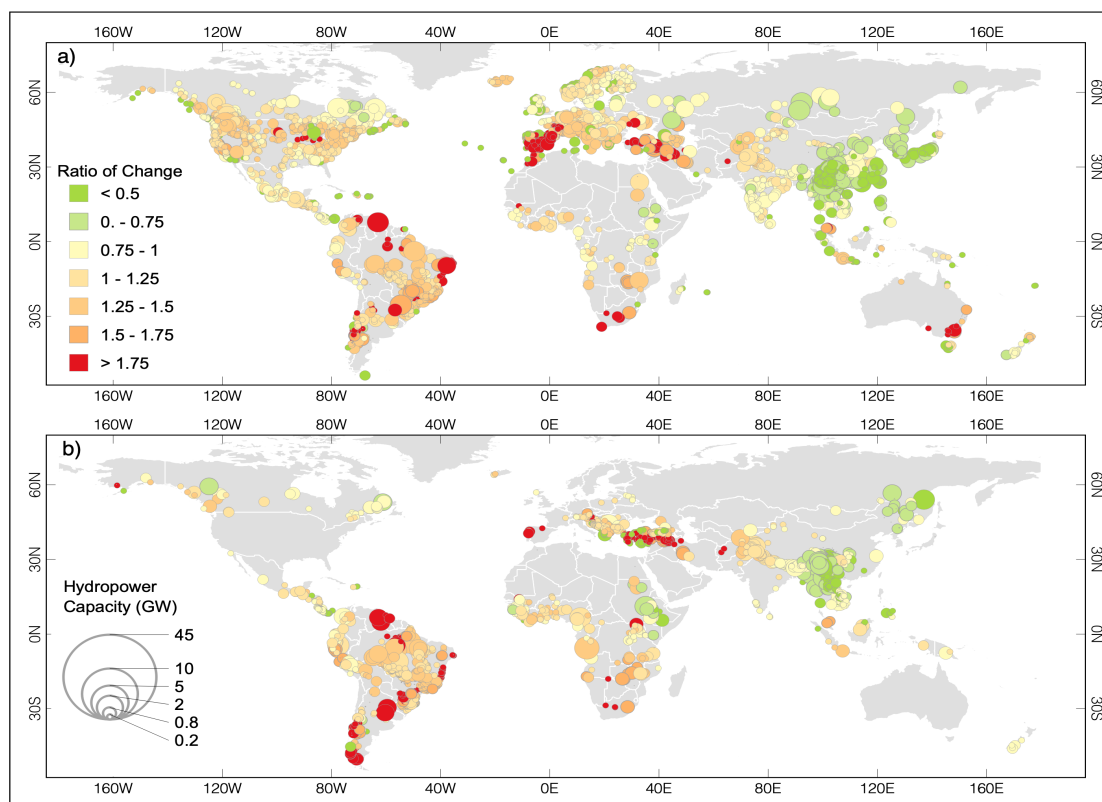
Supplementary 7 – Present and Planned Hydropower Capacities at Risk in a 2.0°C scenario



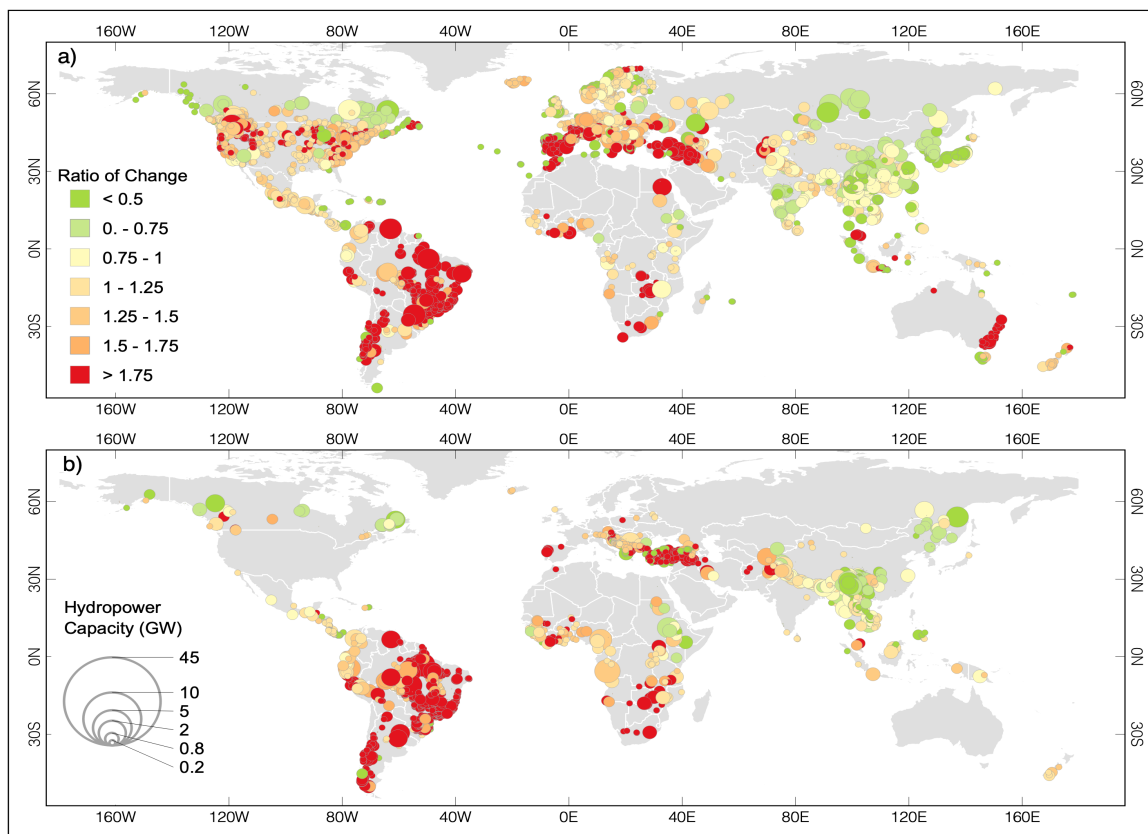
Supplementary Figure 6.1 Gross Hydropower Potential a)Current, b) Planned Hydropower Capacity



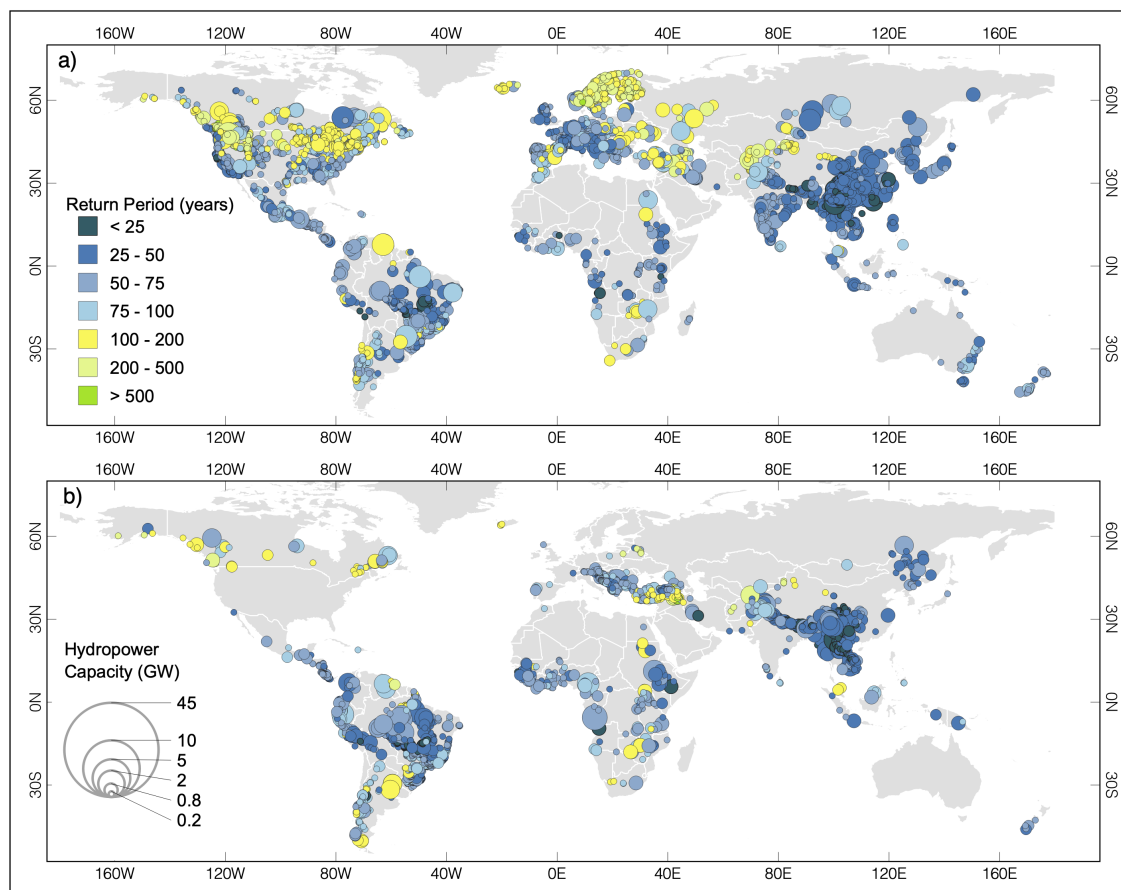
Supplementary Figure 6.2 Drought Frequencies a)Current, b) Planned Hydropower Capacity



Supplementary Figure 6.3 Drought Durations a)Current, b) Planned Hydropower Capacity



Supplementary Figure 6.4 Drought Intensities a)Current, b) Planned Hydropower Capacity



Supplementary Figure 6.5 100-year return period a)Current, b) Planned Hydropower Capacity

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