Supporting Information

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SI Text S1. Calibration of Discharge for Estimation of Energy Generation Potential

For each scenario, we calculated energy generation potential based on the simulated discharge at the Altamira gauge (1). We only calculated the power generated by the main dam and plant, Belo Monte, not the auxiliary plant and dam (Pimentel) because the former is responsible for 98% of the complex's power generation capacity. The maximum power value after calibration was established at 11,000 MW—the maximum installed capacity of the Belo Monte plant alone—even if the calculated value was greater because the turbines would not be able to convert the excess flow.

We calibrated the simulated mean monthly discharge for each scenario to data used by project engineers to calculate projected minimum energy production. First, we calibrated simulated discharge with the official observed mean annual discharge used by project engineers (Table S3). The period of observed data were 1931–2003; deforestation in the Amazon and Xingu River basins was low for at least two-thirds of that period. Vegetation cover in the region over that time period likely ranges between that represented in the 0% and 15% Amazon deforestation scenarios we simulated. We calculated the relationship between the observed annual average and the simulated averages for four scenarios and averaged these to obtain a calibration factor of 0.71.

Next, we reduced the simulated discharge by the amount of stream flow intended to remain in the river in each month, as dictated by the "environmental flow" hydrograph developed for the project. Brazilian legislation requires that hydroelectric developers identify and create mechanisms for maintaining the environmental flow of a river that is to be used or modified to generate hydropower (2). In the case of the Belo Monte, two environmental flows were developed (Table S1). They differ in the minimum flow they maintain during the rainy season (March to June), with the primary option maintaining one-half the maximum monthly flow in April that the secondary option maintains. The project's official viability study indicates that if in any given year the natural (unaltered, before reaching the complex) mean monthly flow does not reach 8,000 $m^3 \cdot s^{-1}$ in any month, then for the next year, project operators must maintain the secondary environmental flow option. We adjusted the discharge values for each scenario over the 33-y time period accordingly, subtracting the primary minimum flow amount from the estimated monthly mean discharge, and then determining whether the subsequent year's discharge would be minimized by the primary or secondary environmental flow option.

Using this reduced flow, we estimated the energy generation potential under each scenario using the following equation:

$$P_m = \Delta h \times Q_m \times g \times EF \times C_{AE} ,$$

where P_m is mean monthly hydropower potential (in megawatts); Δh is difference in head, 87.5 m (2); Q_m is adjusted mean monthly discharge (in cubic meters per second); g is the force of gravity, 9.81 $m \cdot s^{-2}$; EF is the efficiency factor given for the turbines and generators (0.918) (2); and C_{AE} is an additional calibration factor (0.92). C_{AE} was derived by dividing the assured mean annual energy output cited in project documents (4,419 MW) by the uncalibrated power generation potential of the average mean monthly discharge for the average observed year (Table S1) reduced by the remaining downstream flow (as described above). We carried out this additional calibration to be able to compare our results directly to those reported in official project documents, as official values for any power plant's potential are calculated as a function of its contribution to Brazil's national grid (Sistema Interligado Nacional) and require modeling of the entire grid.

Our calculation does not consider the effect of the 440-km^2 reservoir created by the dam, because it is not large enough to alter the run-of-the-river design of the complex. Additional corrections may have been carried out by project proponents; thus, energy generation potential under all of our scenarios is likely to differ in some measure from that reported in project documents. Nevertheless, our simulations are internally consistent and comparable, and we have made every attempt to calibrate our data to official data.

SI Text S2. Statistical Analyses

We compared annual and monthly mean discharge, precipitation, and power potential for each scenario using analysis of one-way variance (ANOVA). Where necessary, data were normalized using a log-normal transformation. Data were tested for homogeneity of variance before comparison. We used Tukey's honestly significant difference post hoc tests to identify statistically different groups of scenarios. We first compared annual means of the simulations without indirect effects [not simulated using the Community Climate Model (CCM3)] with those of the comparable simulations with indirect effects (simulated using CCM3) [e.g., 0% Amazon Basin (AB) and 0% Xingu Basin (XB), 0% AB and 20% XB, and 0% AB and 40% XB] to establish that there was no significant difference between the with-feedback scenarios with indirect effects corresponding to each direct effect-only scenario. Subsequently, we only compared among the simulations that included the indirect effects to establish differences among scenarios varying local and regional forest cover.

1. Coe MT, Costa MH, Soares-Filho BS (2009) The influence of historical and potential future deforestation on the stream flow of the Amazon River—land surface processes and atmospheric feedbacks. *J Hydrol (Amst)* 369(1-2):165–174.

2. Empresa de Pesquisa Energética (2010) *Calculo da Garantia Fisica da UHE Belo Monte. Estudos para a Licitacao da Expansao da Geracao* (Ministério de Minas e Energia/Secretário de Planejamento e Desenvolvimento Energético, Brasilia, Brazil).

Table S1. Estimated mean monthly and annual discharge (*R*) ($m^3 \cdot s^{-1}$) from the Xingu River and precipitation (*P*) ($m^3 \cdot s^{-1}$) summed over the Xingu River basin under alternative scenarios of local [Xingu Basin (XB)] forest cover, with and without climate feedbacks

	With direct effects only						With direct and indirect effects					
	0% XB		20% XB		40% XB		0% XB and 0% AB		20% XB and 0% AB		40% XB and 0% AB	
Month	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*
Jan	9,389[a] (469)	48,978[a] (1,370)	9,695[a] (480)	48,978[a] (1,370)	10,199[a] (502)	48,978[a] (1,370)	10,811[a] (522)	58,690[b] (911)	18,182[b] (1,257)	59,789[b] (1,122)	11,130[a] (569)	59,954[b] (1,114)
Feb	14,737[a,b] (631)	60,522[a] (1,429)	15,227[a] (629)	60,522[a] (1,429)	16,130[a] (640)	60,522[a] (1,429)	15,702[a] (707)	60,582[a] (987)	14,785[a,b] (714)	60,307[a] (1,065)	12,178[b] (631)	61,436[a] (1,126)
Mar	22,095[b] (857)	57,486[a] (1,665)	22,778[b] (862)	57,486[a] (1,665)	24,077[b] (880)	57,486[a] (1,665)	21,534[b] (995)	61,612[a] (1,085)	20,823[b] (992)	60,606[a] (1,266)	31,332[a] (2,234)	61,108[a] (1,113)
Apr	26,465[a,b] (1,162)	35,190[a] (1,219)	27,274[a,b] (1,155)	35,190[a] (1,219)	28,651[a] (6,537)	35,190[a] (1,219)	24,906[a,b] (1,261)	36,156[a] (920)	22,576[b] (1,120)	37,160[a] (1,048)	26,524[a,b] (1,529)	36,888[a] (959)
May	20,494[a,b] (920)	14,329[a] (911)	21,214[a] (907)	14,329[a] (911)	22,261[a] (879)	14,329[a] (911)	19,292[a,b,c] (1,010)	12,147[a] (366)	16,340[c] (887)	12,153[a] (319)	17,306[b,c] (981)	11,665[a] (382)
Jun	10,515[a,b,c] (442)	5,095[a] (486)	11,052[a,b] (441)	5,095[a] (486)	11,779[a] (432)	5,095[a] (486)	10,092[a,b,c] (523)	5,817[a] (269)	8,877[c] (494)	6,406[a] (273)	9,379[b,c] (531)	6,158[a] (286)
Jul	5,149[a,b,c] (204)	2,456[b] (299)	5,485[a,b] (204)	2,456[b] (299)	5,955[a] (201)	2,456[b] (299)	4,913[b,c] (239)	3,282[a] (153)	4,473[c] (221)	3,403[a] (149)	4,520[c] (225)	3,208[a] (188)
Aug	2,596[b,c] (99)	4,647[a] (522)	2,851[a,b] (98)	4,647[a] (522)	3,230[a] (96)	4,647[a] (522)	2,543[b,c] (123)	3,973[a] (265)	2,652[b,c] (151)	4,267[a] (314)	2,370[c] (117)	3,773[a] (322)
Sep	1,538[b] (70)	13,126[a] (794)	1,747[a,b] (70)	13,126[a] (794)	2,078[a] (68)	13,126[a] (794)	1,692[b] (134)	10,325[a,b] (697)	1,773[b] (155)	8,512[b] (519)	1,505[b] (111)	8,885[b] (777)
Oct	1,951[a,b] (189)	26,848[b] (1,338)	2,138[a,b] (188)	26,848[b] (1,338)	2,441[a] (186)	26,848[b] (1,338)	2,341[a,b] (264)	43,608[a] (1,414)	1,687[b] (159)	42,304[a] (1,589)	2,968[a] (359)	40,911[a] (1,726)
Nov	4,392[c] (421)	36,088[b] (1,440)	4,575[c] (414)	36,088[b] (1,440)	4,884[b,c] (401)	36,088[b] (1,440)	4,639[c] (434)	74,507[a] (733)	7,598[a,b] (824)	73,891[a] (862)	9,645[a] (1,035)	74,258[a] (752)
Dec	6,762[b] (469)	43,223[b] (1,706)	7,010[b] (465)	43,223[b] (1,706)	7,414[b] (466)	43,223[b] (1,706)	7,238[b] (506)	72,727[a] (834)	15,037[a] (1,134)	71,328[a] (699)	11,657[a] (942)	71,968[a] (809)
Annual	10,507[a] (445)	28,999[a] (1,065)	10,920[a] (455)	28,999[a] (1,065)	11,592[a] (472)	28,999[a] (1,065)	10,475[a] (432)	36,952[a] (1,389)	11,234[a] (430)	36,677[a] (1,382)	11,709[a] (530)	36,684[a] (1,399)

SE (SEM) is presented in parentheses under each mean. Statistically similar subgroups ($P < 0.01$) in each month and across the whole year are indicated by different letters. $n = 33$ for all months and scenarios. AB, Amazon Basin.

Table S2. Estimated mean monthly and annual discharge (*R*) ($m^3 \cdot s^{-1}$) from the Xingu River and precipitation (*P*) ($m^3 \cdot s^{-1}$) summed over the Xingu River basin under alternative scenarios of local [Xingu Basin (XB)] and regional [Amazon Basin (AB)] forest cover with climate feedbacks included

	0% XB and 0% AB		20% XB and 0% AB		40% XB and 0% AB		20% XB and 15% AB		40% XB and 15% AB		20% XB and 40% AB		40% XB and 40% AB	
Month	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*	*R*	*P*
Jan	10,811^{b,c}	58,690^{a,b}	18,182^{a}	59,789^{a,b}	11,130^{b,c}	59,954^{a}	9,872^{c}	58,982^{a,b}	12,574^{b,c}	58,937^{a,b}	13,547^{b}	55,515^{b,c}	5,536^{d}	53,624^{c}
	(522)	(911)	(1,257)	(1,122)	(569)	(1,114)	(626)	(889)	(895)	(843)	(1,065)	(1,088)	(378)	(1,232)
Feb	15,702^{a}	60,582^{a}	14,785^{a,b}	60,307^{a,b}	12,178^{b}	61,436^{a}	14,899^{a}	61,691^{a}	13,148^{a,b}	61,143^{a}	8,382^{c}	55,866^{b,c}	7,460^{c}	55,095^{c}
	(707)	(987)	(714)	(1,065)	(631)	(1,126)	(701)	(1,047)	(662)	(998)	(507)	(1,184)	(476)	(1,288)
Mar	21,534^{b,c}	61,612^{a}	20,823^{b,c}	60,606^{a}	31,332^{a}	61,108^{a}	25,892^{b}	59,192^{a,b}	20,231^{c}	60,320^{a}	11,932^{d}	55,412^{b,c}	14,934^{e}	53,100^{c}
	(995)	(1,085)	(992)	(1,266)	(2,234)	(1,113)	(1,395)	(1,125)	(988)	(1,222)	(708)	(1,131)	(774)	(1,086)
Apr	24,906^{a,b}	36,156^{a,b}	22,576^{a,b,c}	37,160^{a}	26,524^{a}	36,888^{a}	21,322^{b,c}	34,460^{a,b}	23,781^{a,b,c}	35,173^{a,b}	14,952^{d}	34,267^{a,b}	19,815^{d}	32,728^{b}
	(1,261)	(920)	(1,120)	(1,048)	(1,529)	(959)	(1,133)	(890)	(1,333)	(968)	(819)	(848)	(1,043)	(700)
May	19,292^{a}	12,147^{a}	16,340^{a,b}	12,153^{a}	17,306^{a,b}	11,665^{a}	11,454^{d}	11,272^{a}	15,147^{b,c}	11,655^{a}	11,337^{d}	11,526^{a}	12,276^{c,d}	11,516^{a}
	(1,010)	(366)	(887)	(319)	(981)	(382)	(608)	(396)	(849)	(284)	(667)	(336)	(705)	(418)
Jun	10,092^{a}	5,817^{a}	8,877^{a}	6,406^{a}	9,379^{a}	6,158^{a}	6,179^{b}	5,926^{a}	7,059^{b}	5,808^{a}	5,564^{b}	5,417^{a}	6,379^{b}	5,542^{a}
	(523)	(269)	(494)	(273)	(531)	(286)	(315)	(346)	(349)	(329)	(276)	(234)	(329)	(254)
Jul	4,913^{a}	3,282^{a,b}	4,473^{a}	3,403^{a}	4,520^{a}	3,208^{a,b}	3,339^{b}	2,937^{a,b,c}	3,635^{b}	2,797^{a,b,c}	2,970^{b}	2,377^{c}	3,404^{b}	2,650^{b,c}
	(239)	(153)	(221)	(149)	(225)	(188)	(162)	(176)	(174)	(164)	(140)	(132)	(163)	(139)
Aug	2,543^{a}	3,973^{a,b}	2,652^{a}	4,267^{a}	2,370^{a,b}	3,773^{a,b}	1,876^{c}	3,110^{b,c}	1,973^{b,c}	3,009^{b,c}	1,755^{c}	2,369^{c}	1,977^{b,c}	2,365^{c}
	(123)	(265)	(151)	(314)	(117)	(322)	(90)	(229)	(92)	(169)	(90)	(92)	(96)	(83)
Sep	1,692^{a,b}	10,325^{a}	1,773^{a}	8,512^{a}	1,505^{a,b,c}	8,885^{a}	1,208^{c}	6,183^{b}	1,243^{b,c}	5,785^{b}	1,244^{b,c}	6,342^{b}	1,324^{a,b,c}	5,978^{b}
	(134)	(697)	(155)	(519)	(111)	(777)	(78)	(274)	(85)	(196)	(105)	(240)	(98)	(321)
Oct	2,341^{a,b}	43,608^{a}	1,687^{b,c}	42,304^{a}	2,968^{a}	40,911^{a}	1,198^{c}	31,522^{b}	1,505^{b,c}	27,220^{b}	1,209^{c}	28,353^{b}	1,094^{c}	24,837^{b}
	(264)	(1,414)	(159)	(1,589)	(359)	(1,726)	(113)	(1,850)	(148)	(1,488)	(135)	(1,708)	(107)	(1,524)
Nov	4,639^{c,d}	74,507^{a}	7,598^{a,b}	73,891^{a}	9,645^{a}	74,258^{a}	4,294^{c,d}	71,223^{a,b}	6,524^{b,c}	70,915^{a,b,c}	3,706^{c,d}	68,421^{b,c}	1,965^{d}	65,677^{c}
	(434)	(733)	(824)	(862)	(1,035)	(752)	(491)	(1,027)	(899)	(1,087)	(428)	(1,856)	(175)	(1,923)
Dec	7,238^{c}	72,727^{a}	15,037^{a}	71,328^{a}	11,657^{a,b}	71,968^{a}	6,934^{c}	70,443^{a,b}	11,269^{b}	69,996^{a,b}	10,951^{b}	67,300^{b}	3,960^{c}	63,081^{c}
	(506)	(834)	(1,134)	(699)	(942)	(809)	(555)	(844)	(1,016)	(728)	(965)	(1,146)	(283)	(1,293)
Annual	10,475^{a,b,c}	36,952^{a}	11,234^{a,b}	36,677^{a}	11,709^{a}	36,684^{a}	9,039^{c}	34,745^{a}	9,841^{b,c}	34,397^{a}	7,296^{d}	32,764^{a}	6,677^{d}	31,350^{a}
	(432)	(1,389)	(430)	(1,382)	(530)	(1,399)	(432)	(1,381)	(418)	(1,382)	(300)	(1,315)	(321)	(1,262)

SE (SEM) is presented in parentheses under each mean. Statistically similar subgroups ($P < 0.01$) in each month and across the whole year are indicated by different letters. $n = 33$ for all months (and annual mean) and scenarios.

Table S3. Observed rainfall and streamflow for the Xingu River compared with streamflow values used in official Belo Monte hydroelectric complex planning data

	Observed 1968–2000		Official project data		
			Actual discharge	Environmental flow	
Month	Precipitation*	Discharge†	Average year‡	Primary option§	Secondary option‖
Jan	49,027	9,546	7,803	1,100	1,100
Feb	59,559	15,274	12,759	1,600	1,600
Mar	57,946	20,640	18,178	2,500	4,000
Apr	35,154	20,845	20,028	4,000	8,000
May	14,314	15,861	15,784	1,800	4,000
Jun	5,163	7,263	7,156	1,200	2,000
Jul	2,436	3,378	2,902	1,000	1,200
Aug	5,188	1,821	1,571	900	900
Sep	13,040	1,281	1,069	750	750
Oct	27,025	1,367	1,120	700	700
Nov	35,916	2,209	1,891	800	800
Dec	43,748	4,492	3,754	900	900
Annual	29,043	8,634	7,834	1,438	2,162

All values are in units of cubic meters per second ($m^3 \cdot s^{-1}$).

*Observed mean monthly and annual precipitation (1) for the 1968–2000 period, interpolated and summed over the XB (2).

†Observed mean monthly and annual discharge of the Xingu River at Gauge 44 for the period from 1968 to 2000).

‡Xingu River discharge values at Gauge 44 defined as the "average" year in official project documents (3).

§,‖Primary option§ and secondary option‖ of environmental flow planned to remain in the Xingu River downstream of the diversion for Belo Monte hydroelectric complex (3).

1. Coe MT, Costa MH, Soares-Filho BS (2009) The influence of historical and potential future deforestation on the stream flow of the Amazon River - Land surface processes and atmospheric feedbacks. *J Hydrol (Amst)* 369(1-2):165–174.
2. Empresa de Pesquisa Energética (2010) *Calculo da Garantia Fisica da UHE Belo Monte. Estudos para a Licitacao da Expansao da Geracao* (Ministério de Minas e Energia/Secretário de Planejamento e Desenvolvimento Energétic, Brasilia, Brazil) (Energia MdMe).
3. New M, Hulme M, Jones P (1999) Representing twentieth-century space-time climate variability. Part I: Development of a 1961–90 mean monthly terrestrial climatology. *J Clim* 12:28.

Table S4. Estimated mean monthly and annual power (MW) projected to be generated from Xingu River flow under alternative local [Xingu Basin (XB)] and regional [Amazon Basin (AB)] forest cover scenarios

	0% XB and 0% AB	20% XB and 0% AB	40% XB and 0% AB	20% XB and 15% AB	40% XB and 15% AB	20% XB and 40% AB	40% XB and 40% AB
Jan	4,998^{b,c} (269)	8,055^{a} (445)	5,162^{b,c} (293)	4,515^{c} (322)	5,892^{b,c} (455)	6,234^{b} (492)	2,300^{d} (196)
Feb	7,238^{a} (357)	6,774^{a,b} (363)	5,444^{c} (325)	6,829^{a} (355)	5,944^{a,b} (341)	3,491^{c} (261)	3,041^{c} (246)
Mar	9,081^{a,b} (356)	8,830^{a,b} (375)	1,015^{a} (314)	9,900^{a,b} (308)	8,632^{b} (386)	4,855^{c} (364)	6,421^{d} (396)
Apr	9,391^{a} (328)	8,711^{a,b} (352)	9,638^{a} (325)	8,272^{a,b} (392)	8,896^{a,b} (349)	5,637^{c} (422)	8,331^{b} (161)
May	8,511^{a} (394)	7,373^{a,b} (418)	7,792^{a,b} (428)	4,969^{d} (313)	6,808^{b,c} (414)	4,909^{d} (343)	5,420^{c,d} (361)
Jun	4,577^{a} (269)	3,952^{a} (254)	4,210^{a} (273)	2,563^{b} (162)	3,016^{b} (179)	2,246^{b} (142)	2,684^{b} (169)
Jul	2,040^{a} (123)	1,787^{a} (114)	18,124^{a} (116)	1,204^{b} (84)	1,356^{b} (89)	1,014^{b} (72)	1,253^{b} (84)
Aug	846^{a} (63)	902^{a} (77)	756^{a,b} (60)	503^{c} (46)	552^{b,c} (48)	441^{c} (46)	568^{b,c} (50)
Sep	485^{a,b} (69)	527^{a} (80)	389^{a,b,c} (57)	238^{c} (40)	255^{b,c} (43)	255^{b,c} (54)	308^{a,b,c} (50)
Oct	847^{a,b} (135)	512^{b,c} (81)	1,169^{a} (185)	272^{c} (55)	426^{b,c} (74)	283^{c} (67)	231^{c} (51)
Nov	1,976^{c,d} (223)	3,499^{a,b} (424)	4,481^{a} (500)	1,798^{c,d} (253)	2,914^{b,c} (444)	1,498^{c,d} (220)	616^{d} (87)
Dec	3,262^{c} (261)	7,045^{a} (520)	5,443^{a,b} (440)	3,106^{c} (286)	5,316^{b} (516)	5,173^{b} (497)	1,589^{c} (142)
Annual	4,436^{a} (179)	4,831^{a} (186)	4,698^{a} (182)	3,681^{b,c} (173)	4,167^{a,b} (178)	3,003^{c,d} (139)	2,684^{d} (139)

SE (SEM) is presented in parentheses under each mean. Statistically similar subgroups ($P < 0.01$) in each month and across the whole year are indicated by different letters. $n = 33$ for all months (and annual mean) and scenarios.