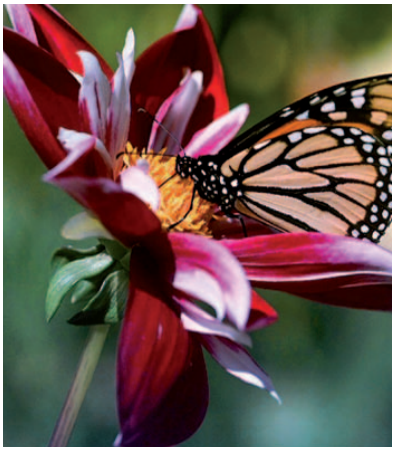


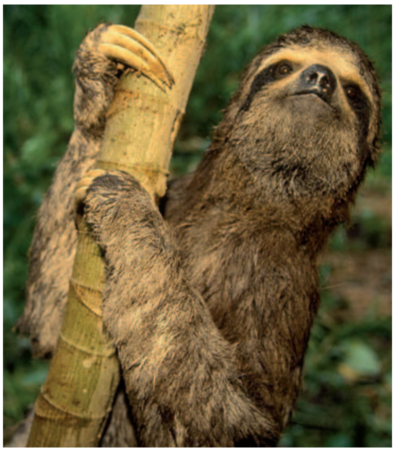


Climate Scenarios for the Mayo River Basin to 2030


SECOND NATIONAL COMMUNICATION ON CLIMATE CHANGE

EXECUTIVE SUMMARY

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CLIMATE SCENARIOS FOR THE MAYO RIVER BASIN TO 2030
Executive Summary

SENAMHI
National Meteorology and Hydrology Service
Numerical Prediction Center – CPN
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EXECUTIVE SUMMARY

Climate Scenarios for the Mayo River Basin

TO 2030

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Background

The Mayo River basin, is located in the Region of San Martin as part of the Larger Amazon River basin; it has a hilly physiography and is home to a diversity of ecosystems that makes it particularly special for the development of important species of flora and fauna at a global level. However, as in other regions of the Peruvian jungle, threats of several kinds, such as degradation of ecosystems, arise as a result of deforestation, construction of highways, human settlement, indiscriminated extraction of native species, etc., which added to hydrometorological hazards , such as intense precipitations, floods, droughts, changes in the air temperature variability, among others, makes the different ecosystems in the basin highly vulnerable.

On this matter, the Ministry of Environment, within the framework of the Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC), a project that has the support of the United Nations Development Program – UNDP, has coordinated with SENAMHI to perform a study on "Climate Scenarios for the Mayo River Basin to 2030", which describes two important aspects of climate: the present climate, where based on time series of more than 40 years, changes in rainfall and maximum and minimum temperature patterns have been evaluated, as well as extreme events and future climate, using statistical and dynamical methods to generate scenarios for year 2030. The projected variables are extreme temperatures and precipitation that will allow to determine the areas under accelerated climate change processes with respect to their mean values and that would imply higher impacts on socio-economic activities in the basin.

It is important to point out that each step of the study considers an uncertainty element, not only on the part of the historical analysis and limited knowledge on climate variability; but also the methods used to generate future projections for the basin, which gradually incorporate uncertainties. However, the results obtained in this study are based on standard methodologies recognized by the IPCC, that allow to improve our knowledge on current and future vulnerability and orient the most adequate policies to face climate change in the Mayo River Basin, contributing to regional development.

The Peruvian Amazon Jungle: Lung of the world

The Amazonia or Amazon Jungle is the largest rainforest in the world; it includes nine South American countries. The largest areas of rainforest belong to Brazil and Peru. The Amazon rainforest covers 60% of Peruvian territory and it is an area with the greatest biodiversity in the planet.

In this vast territory, called Peruvian Amazon, is located the Mayo River basin, which is elongated and follows predominantly a northwest-southeast direction. From its source it adopts a form that gets progressively wider up to half of its course (Gera river mouth). Downstream, the river channel gets narrow until it meets the Huallaga River. Mayo is the main river and it has an approximate length of 254.49 Km. The Mayor River basin forms a vast valley densely populated, where important cities such as Rioja, Moyobamba and Tarapoto are located.

The upper and middle zone of the basin, called Alto Mayo, is located in the northern region of the high jungle of Peru, compresing of the provinces of Rioja, Moyobamba (San Martin Region) and the province of Rodriguez de Mendoza, that belongs to the Region of Amazonas. The Alto Mayo, is located at 77º 45' 53" – 77º12' 77" west longitude and 5º 23' 04" – 6º 10' 56" south latitude. To the north it is bordered by the Region of Loreto, to the west it is bordered by the Department of Amazonas and to the south with Tabalosos.

In the lower part of the basin, called Bajo Mayo, important locations such as Shapaja, Tabalosos, Lamas, Cacatachi, Zapatero, Tarapoto and Juan Guerra are located.

The basin shows great spatial variability in precipitations as well as in maximum and minimum temperatures. The highest maximum temperatures are registered in the Bajo Mayo, near the southeast limit, around El Porvenir, where in average temperature reaches 32,8 ºC. The lowest values of maximum temperature occur in the Alto Mayo where it registers values lower than 20 ºC above 2000 m altitude.

Minimum temperatures show its highest values in the Bajo Mayo, exceeding in average 20 ºC in the El Porvenir area; meanwhile, the lowest values are registered in the highest part of the basin, where minimum temperature shows values below 10 ºC close to the border with the Region of Amazonas and above 2 000 meters above sea level.

Also, precipitations in the Mayo basin, increase from southeast to northwest with values that fluctuate between 800 mm/year to 2 000 mm/year. The zones with the highest precipitation values are located in the Bajo Mayo area, in Tarapoto and Soritor, where precipitations reach values a little bit higher than 1800 mm/year. The zones with less precipitations are located in the higher parts of the basin, where rainfall reaches less than 1 000mm/year. It is also important to point out that temporal and spatial variation of maximum and minimum temperatures and precipitation during some episodes of the El Niño and La Niña has shown little evidence of its effects.

The different climates in the zone

The Mayo River basin has a very complex topography, also the form of the basin and its orientation determines the presence of four diverse climates, according to the climate classification made by SENAMHI, 1988. Thus, in the foothills west of the basin, (over 2 000 meters above sea level) the climate (C(o,i) B'2H3) is semi-dry and there is rainfall shortage in autumn and winter and with high relative humidity.

In the remaining part of the basin, topography ranges from 200 to 2 000 meters above sea level and the vegetation is exuberant; these local characteristics are conclusive for its climate classification. The existing climates in this region, range from a (B (i)B'1 H3) rainy semi-warm climate with rainfall shortage in winter and high relative humidity (Rioja) to a (B (r)A' H4) rainy warm climate with plenty of rainfall in all the seasons and very humid (Yuracyacu, Jepelacio, Moyobamba, Yurimaguas, Lamas).

While, the southeast area of the basin, next to the right banks of the Mayo River is characterized for presenting a (C(o,i,p) A'2 H3) warm climate with rainfall shortage in autumn, winter and spring, with high relative humidity, and the main locations that follow this classification are Shapaja and Tabalosos.

Are there any precipitations trends?

Rainfall records in the last 40 years show an increasing annual trend statistically significant in the locations of Tabalosos, with values between 40% and 50%, and Pacaysapa (location where the basin gets narrower) between 90% and 100%, with respect to their average values. Trouble is that, in the zone of the locations with significant increases in precipitation local is because local conditions respond in a different way to large scale conditions that modulate precipitation in the whole basin, since in that zone the basin gets narrower and it is very likely the cause for a higher increase in the orographic kind of precipitations. In the other locations of the basin, trends range between -20% and +20%, which means that there are no significant increases or decreases signs in total annual precipitations

Precipitations throughout the year show a very regional behavior, which is evident in the behavior of total annual values and in all the seasons of the year, mainly in the summer (DJF). In the summer, locations such as Jepelacio and El Porvernir show little negative trends, less than 40%, which indicates us that rainfall throughout the years has been decreasing; the opposite behavior is observed in the other locations in the basin, such as in Moyobamba and mainly in Pacaysapa, in this last one the increase in rainfall reaches very high rates, between +110% and +120%.

During winter, it is observed a decrease in rainfall within the basin, with values that reach between -40% and -50% statistically significant in the location of Rioja; except for very specific locations such as Pacaysapa and Tabalosos where rainfall is increasing in all the seasons of the year.

Concerning spring and autumn spatial patterns, they show very similar behaviors, with prevalence of little increases and decreases of rainfall, except for locations where the basin shows a narrow form.

Temperature Trends

Trends in yearly mean maximum temperatures in Moyobamba and El Porvenir, follow opposite trends through the years, with statistically significant values, also there is slight evidence of the effects of the ENSO events (El Niño Southern Oscillation) on the behavior of temperature. Moyobamba shows a decreasing trend of -0,25 ºC/decade, while El Porvenir show a positive trend of + 0,43 ºC/decade.

Distribution of seasonal mean maximum temperature show that the directions of the trends are similar to the annual mean, with maximum values of +0,52 ºC/decade observed during summer in El Porvenir and -0,39 ºC/decade in Moyobamba in the summer. All trend values are statistically significant. During the four seasons of the year, both locations apparently show in their records, some long time scales modulations at seasonal an annual levels. Also, signal of ENSO events concerning interannual variability is minimum, only the winter season of 1983 and 1997 in Moyobamba, which is also the season that show a lower negative trend with -0,15 ºC/decade. In El Porvenir the lowest increase occurs in autumn with +0,33 ºC/decade.

Annual mean minimum temperatures in El Porvenir and Moyobamba, both located in the Mayo basin, show positive trends of +0,22 ºC/decade and +0,48 ºC/decade, respectively, being statistically significant in Moyobamba.

In both series of minimum temperature (Moyobamba and El Porvernir) it is observed a high interannual variability in the 1970's decade, with very low values in the summer of 1971/72 in El Porvenir, and in 1977 both stations are related to the warm events of the ENSO. Gradual increases in minimum temperature are observed starting the 1980's decade, as well as little interannual variability with no long-term oscillation signal.

Seasonal minimum temperature trend shows the same characteristics observed at annual scale. The value of the positive trend is higher in Moyobamba than in El Provenir, in all the seasons of the year. The highest value of the trend is registered during summer in Moyobamba with +0,57 ºC/decade and with +0,27 ºC/decade in El Porvenir, while the lowest increases were observed in autumn with +0,13 ºC & decade in El Porvenir and 0,33 ºC /decade in Moyobamba in the winter.

Are extreme precipitation indices increasing?

The basin data records show very low positive trends in the consecutive no-rain index (CDD) and only in two locations show statistically significant negative trends, Pacaysapa and San Antonio, which indicates a significant decrease of dry days in the last 40 years.

Conversely, rainy consecutive days (CWD) apparently increased in the basin, but most of the values are very low, and statistically non-significant, except for Pacaysapa, where an increase of rainy days has been registered. Also, in San Antonio there is a possibility that a decrease in dry days may occur, but it doesn't necessarily mean that they will turn into rainy consecutive days.

The accumulated precipitation indices for one day (RX1day) and five days (RX5day) show similar spatial distributions and trends. Both distributions show in general, very small values, either positive or negative, in almost all the locations in the basin, except for Pacaysapa, where the trend of both indices is highly positive and statistically significant. Also, the trend of the RX5day index is positive north of Pacaysapa (Alto Mayo) but with very low values (+0,4 mm/year) showing a possibility of risks in such area, showing opposite conditions to the south (Bajo Mayo).

Spatial distribution of moderate (R10 mm) and intense (R20m) precipitation indices, clearly demonstrate that the zone where Pacaysapa is located, shows significant trends, and it becomes a dividing zone between the two regions with particular precipitation characteristics within the Mayo river basin. In the last years a decrease in the days with moderate and intense precipitation south of Pacaysapa (Bajo Mayo) has been observed, even the location of Cuñumbuque shows statistically significant negative trends, between -0,2 and 0,4 days/year. In Alto Mayo some positive trends are observed, particularly in relation to extreme precipitation with + 0,2 days/year.

Distributions of precipitations intensities, called very rainy days (R95p) and extremely rainy days (R99p) continue to show spatial patterns with characteristics similar to the distribution of the above analyzed indices. The R95p index shows a significant intensity increase, in Pacaysapa (+20 mm/year), besides, it also confirms the existence of an apparent regionalization of precipitation in this basin.

In addition, significant increases in the intensity of extremely rainy days (R99p) were registered in Pacaysapa +15mm&year, while in the other locations some very low positive trends were observed.

Are extreme temperature indices increasing?

Temporal indices for the series of cold days (TX10p) and hot days (TX90p) at the stations of Moyobamba and El Porvenir, has been calculated based on the years 1971 to 2000. Cold days index trends for both locations are negative and non-significant. These trends are the result of high interannual variability observed in Moyobamba before the 1960's decade, and during the 1970's decade in El Porvenir. Additionally, it can be observed that this index in both stations seem to be modulated by long-term oscillations, with evident active periods in the 1970's decade, and around 1990 and 2000, associated with periods of very high interannual variability, and particularly with warm ENSO events in 1972, 1976, 1992 and 2001.

With respect to temporal distributions of warm days index, no trends are observed in both locations. One characteristic that is necessary to point out is the high interannual variability, in which some years are related to the warm phase of ENSO as in 1992, in El Porvenir, but both locations show no modulations due to larger scales.

Cold days index trends (TX10p) in Moyobamba and El Porvenir are negative and non-significant and are the result of high interannual variability observed and modulated by ENSO and long-term oscillations. The warm days index (TX90p) shows no trend (null) in both stations. The cold nights indices (TN10p) and warm nights (TN90p) show similar patterns, without any trend, except for the warm nights in El Porvernir , that has a positive non-significant value. Another characteristic of both distributions is high interannual variability apparently modulated by a different kind of oscillation, other than ENSO.

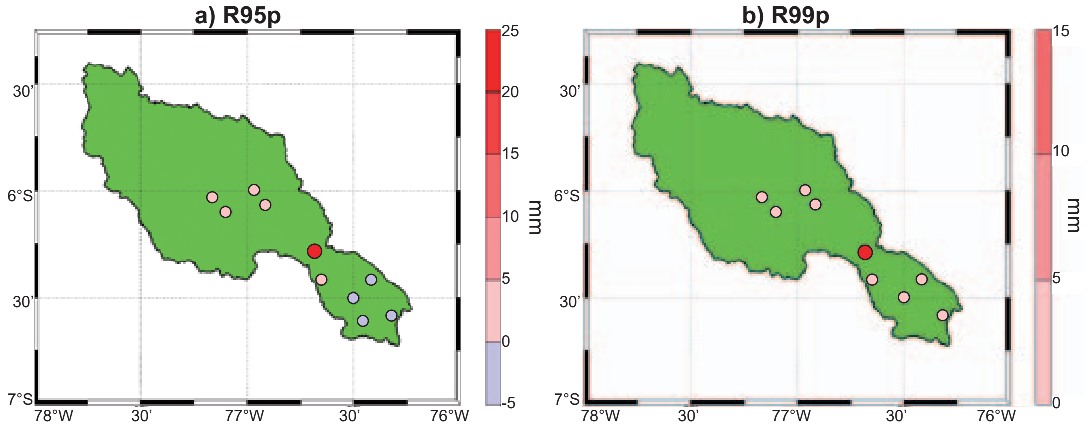
Droughts in the Mayo river basin

On average, meteorological droughts (monthly scale) show high interannual variability, centered in their mean value (0,0) without any increasing or decreasing trend during the period of analysis. Extreme droughts (less than -2,0) practically do not occur; severe droughts (-2,0 to -1,5) were registered in 1990 and 1992 (El Niño years) and moderate droughts (-1,5 to 1,0) are more frequent. An important characteristic is that there is no strong evidence that would indicate a direct relation between the occurrence of droughts and ENSO events, except for the year 1992 in which a severe drought was observed, and in 1997/98, a moderate drought.

At agrometeorological (3 months) and hydrological (1 year) scales there is no trend, but it can be seen a modulation of larger oscillations, other than the interannual. Agrometeorological droughts were mostly moderate and regionalized.

Hydrological droughts in the Mayo river basin are apparently more intense, such as the ones registered at the end of the 1960's decade and beginning of 1980's, which were extreme and persisted for several months and they occurred after the warm events of ENSO in years 1965/66 and 1982/83.

The seasonal linear correlations between the sea surface temperature in the 3,4 Niño and droughts do not show statistically significant coefficients of correlation. But is possible to observe that the region of Alto Mayo is the most prone to undergo droughts during the season of principle rains (Dic - May) and in the Bajo Mayo, the El Porvenir zone. The least prone zone is located between San Antonio and Tabalosos.



Spatial distribution of trends of climate extreme indices for precipitation: a) very rainy days (R95p), 95% percentile and b) extremely rainy days (R99p) 99% percentile, computed for the period 1965-2006 based on the climatology of 1971-2000. Trends with a statistical significance of 5% or less than the Mann-Kendall Test are shown in a black contoured line.

In conclusion:

- The Mayo river basin due to its complex morphology (orography) shows a regional rainfall distribution, with total annual values between 800 to 2000 mm/year.

- Annual rainfall has increased in the basin in the last forty years, mainly in Pacaysapa (100%) and Tabalosos (50%).

- Seasonal rainfall has shown high increases in Pacaysapa and Tabalosos, especially in the summer, while in the winter rainfall tends to diminish between 40 and 50% in most part of the basin.

- The Pacaysapa region is more vulnerable to hydroclimatic hazards due to the increase of extreme rainfall.

- In the Mayo river basin, maximum and minimum temperatures are increasing at a rate of +0,43 ºC/decade and +0,22 ºC/decade respectively. In the case of the Alto Mayo maximum temperature is decreasing at a rate of -0.25 ºC /decade while minimum temperature is increasing at a rate of +0,48 ºC/decade.

- The increases in maximum temperature are higher in spring and summer in the Bajo Mayo , with values between +0,52 and +0,47 ºC/decade; while in Alto Mayo the highest decreasing values occur in summer and autumn between -0.39 and -0,33 ºC/decade.

- The highest increases in minimum temperature in the basin occur in the summer; while the lowest increases occur in autumn and in the winter in Alto Mayo.

- In the last forty years, droughts registered in the basin have been moderate in relation to the intensity, and they show no trend concerning frequency of occurrence.

- ENSO (El Niño) events seem to modulate drought ocurrences in the basin, although there is no clear signal on this matter.

Climate Projections to 2030 for the Mayo River Basin

The scenarios generated for this basin have been made for 2020 and 2030 decades, using techniques applied by international centers, such as statistical and dynamical downscaling. For statistical downscaling the outputs of the global models and sea surface temperature (SST) were used, while for the dynamical downscaling the information from climate scenarios of the CCSM global model of the National Center for Atmospheric Research (NCAR) was used. This one served as boundary conditions for the Regional Atmospheric Model Systems (RAMS) model. The detailed methodology is explained in the study "Climate Scenarios at National Level to 2030" SENAMHI, 2009.

Detailed results have been obtained for the 2030 decade and they are an essential part of the studies on future vulnerability in the priority sectors.

How will maximum temperature be in 2030?

The highest maximum temperature will occur in the middle part of the basin, with values oscillating between 30 and 32 ºC (to the northeast and in Moyobamba). The increases in temperature in this area could be related to land use, deforestation and population growth, mainly in the city of Moyobamba.

Positive changes (positive anomalies) in annual maximum air temperature are projected for the entire basins at a rate of +0,9 to +1,2 ºC. These changes would affect locations such as Naranjos, located to the northwestern part of the basin, Tarapoto and Juan Guerra, both located in the southeastern part of the basin.

In the middle part of the basin temperatures would reach between 24 and 34 ºC for the summer (DJF) of 2030 and in the winter (JJA), between 22 and 30 ºC. Positive anomalies in the summer would be registered in all the sectors of the basin, reaching values of up to +1,8 ºC, mainly in the Bajo Mayo (Tarapoto, Cacatachi, Zapatero and Juan Guerra). For autumn 2030 (MAM) positive anomalies are projected, that would reach up to + 11 ºC (Tarapoto and Juan Guerra). In spring (SON) strong warming anomalies are observed up to +2,1 ºC in the high region (Naranjos) and low region of the Mayo river basin (east of Tarapoto and Juan Guerra locations).

In the winter, weak cooling anomalies are observed, of -0,2ºC in most part of the basin, mainly in the middle and low zones (locations of Soritor, Rioja, Posto, Yuracyacu, Calzada, Habana, Moyobamba, Jepelacio and Shapaja, Pinto Recodo, Tabalosos, Lamas, Cacatachi, Zapatero and Juan Guerra), that probably would be associated with large scale cold circulations in the region (incursion of cold fronts).

Concerning the warm days index for the 2030 decade, they would increase in the whole basin.

And what about minimum temperatures for 2030?

Temperature nucleus with values of 20 – 22 ºC would be observed in Bajo Mayo and minimum values of temperature 2 – 4 ºC should be observed in the northwestern zone of the basin (high basin) or northwest and west of Vista Alegre location. To 2030 some positive changes are projected (positive anomalies) of annual minimum air temperature in the entire basin, values that range between +0,2 to +0,7 ºC, slightly lower than the changes in maximum temperature. The locations that could be affected due to the increase of minimum temperature should be Tarapoto and Juan Guerra.

In the middle and lower part of the basin, temperatures for summer (DJF) should oscillate between 12 -22 ºC, while in winter (JJA) minimum temperatures should show a decrease in the low basin, its projections are between 12 to 20 ºC.

In winter, for most part of the basin weak negative anomalies are projected, between -0,1 and -0,4 , in relation to current values, that would be associated with weak intensifications of "cold fronts" in the region; mainly in the middle zone (Yuracyacu, Posic locations) and in the higher zones (east of Vista Alegre).

While in autumn, increases in temperature should be registered in the basin from +0,3 and +0,9 ºC, with high values to be observed north of Naranjos. In the summer and spring, (rainy period in the basin) warming would reach up to +0.7 and +1,2 ºC respectively, being the locations of Tarapoto, and Juan Guerra the most affected. This warming should be associated with more cloud coverage and not necessarily rainfall occurrence in this region. On the other hand, the warm nights index also show an increasing trend in all the basin.

How should precipitations be in year 2030?

Total annual precipitations should show values similar to its climate averages. These future scenarios will continue to present large precipitation nucleus in the basin, similar to climate averages, as the zones located in the eastern part of the Bajo Mayo, with total annual values of 2 000 mm; and in Alto Mayo, to the western side of the Mayo river (Soritor), concentrate the 1 800 mm nucleus.

At annual level, slight shortages should occur, form -1 to 3%. The lowest negative percentage variations will concentrate east of the basin, both for the Bajo and the Alto Mayo. The largest variations are located in the western part of the Bajo Mayo and in the northeastern part of the Alto Mayo.

In the summer, in the Lower Mayo, precipitations should oscillate between 200 mm/ quarter up to 600 mm/quarter (to the eastern part of the zone), while in the Alto Mayo precipitations should oscillate between 300 and 500 mm/quarter (Soritor).

In autumn, (MAM) rainfall would show values between 300 and 700 mm/quarter in the Bajo Mayo, while in the Alto Mayo it will show amounts similar to the ones in the summer, that is between 300 and 500 mm/quarter.

For winter (JJA), the behavior of precipitations should be similar to its climatological behavior, that is, lower precipitations in the Alto Mayo, with values between 100 and 200 mm/quarter, while in the Bajo Mayo precipitations should vary between 100 and 500 mm/quarter. This behavior is because the Intertropical Convergence Zone will reach its northernmost position, which would cause a decrease in precipitations.

In the Bajo Mayo spring (SON) precipitations should occur similar as in the winter, but will increase in the Alto Mayo. That may be associated to an intense transportation of humidity into the basin, relative to winter. In the Bajo Mayo, precipitations should oscillate between 300 and 500 mm/quarter for the 2030 decade. In the Alto Mayo, rainfall should oscillate between 200 and 400 mm/quarter.

The intense precipitation index (95 percentile) shows a negative trend (decrease of intense rainfall), which is consistent with the present trend.

In conclusion:

- Annual accumulated precipitation should show no important variations for 2030 with respect to its present climatology. At seasonal level, shortages should be between -3% and -7% in the summer, between -2 and -4% in the winter and in spring, while in autumn there should be some increases of up to + 3%. Also, intense rainfall should tend to decrease in the whole basin.

- Maximum and minimum temperature, will increase to 2030 reaching increments of + 1,2 ºC and + 0,7 ºC respectively. Seasonally, the largest changes should occur in spring, with values of up to +2 ºC in the maximum temperature and +1,2 ºC in the minimum temperature.

- For 2030 warm days and nights should increase, mainly in the Bajo Mayo.

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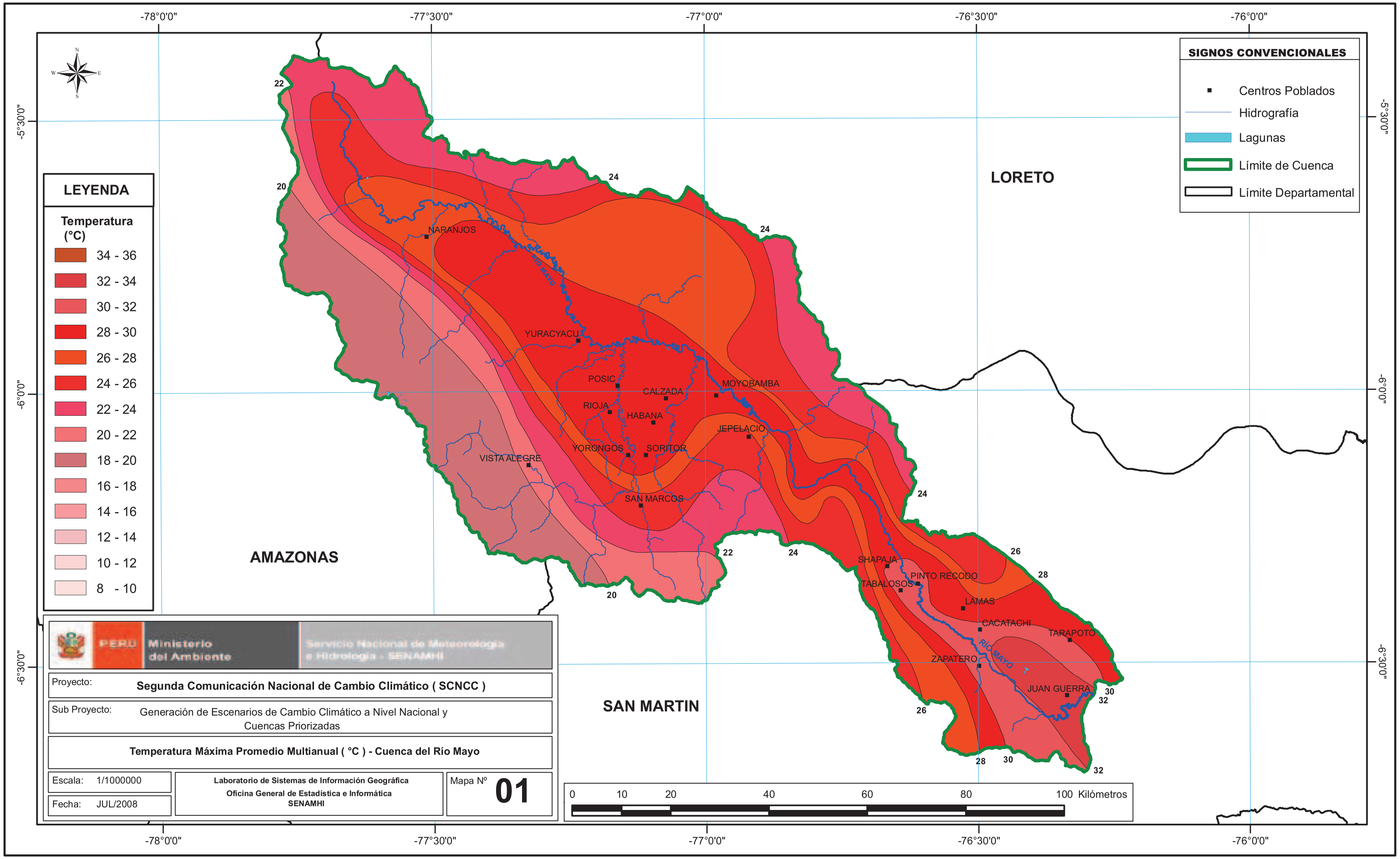
APPENDIX

N° of Map	Name of Map
Map Nº 01:	Multiannual average maximum temperature (ºC)
Map Nº 02:	Multiannual average minimum temperature (ºC)
Map Nº 03:	Total multiannual precipitation (mm)
Map N° 11	Variation of maximun temperature to 2030
Map N° 27	Variation of minimum temperature to 2030
Map N° 43	Variation in percentage of precipitation to 2030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Temperatura (°C)
34 - 36
32 - 34
30 - 32
28 - 30
26 - 28
24 - 26
22 - 24
20 - 22
18 - 20
16 - 18
14 - 16
12 - 14
10 - 12
8 - 10
SIGNOS CONVENCIONALES
Centros Poblados
Hidrografía
Lagunas
Límite de Cuenca
Límite Departamental
LORETO
AMAZONAS
SAN MARTIN
NARANJOS
YURACYACU
POSIC
CALZADA
MOYOBAMBA
RIOJA
HABANA
JEPELACIO
YORONGOS
SORITOR
VISTA ALEGRE
SAN MARCOS
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Sub Proyecto: Generación de Escenarios de Cambio Climático a Nivel Nacional y Cuencas Priorizadas
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Fecha: JUL/2008
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Oficina General de Estadística e Informática
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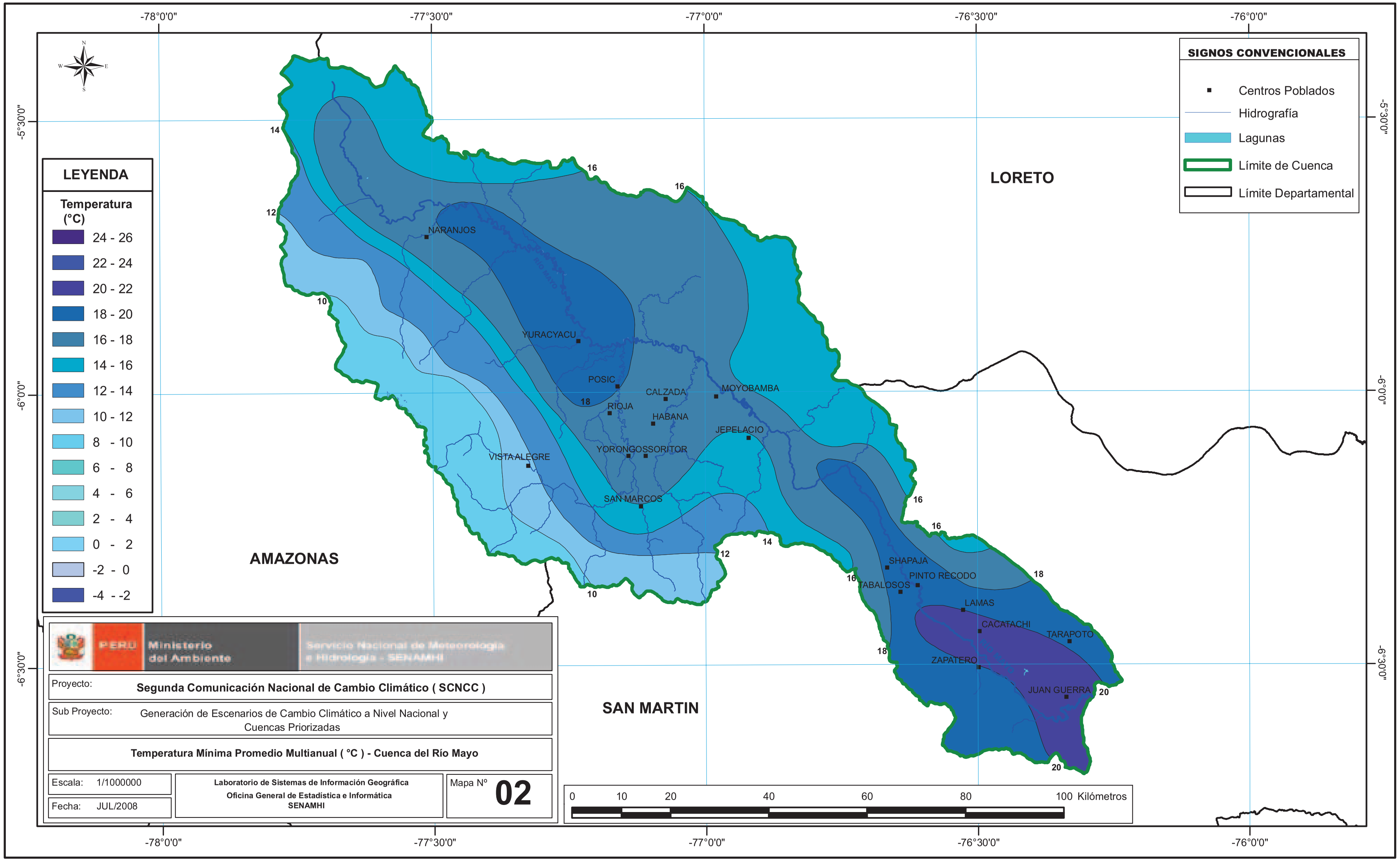
Servicio Nacional de Meteorología e Hidrología - SENAMHI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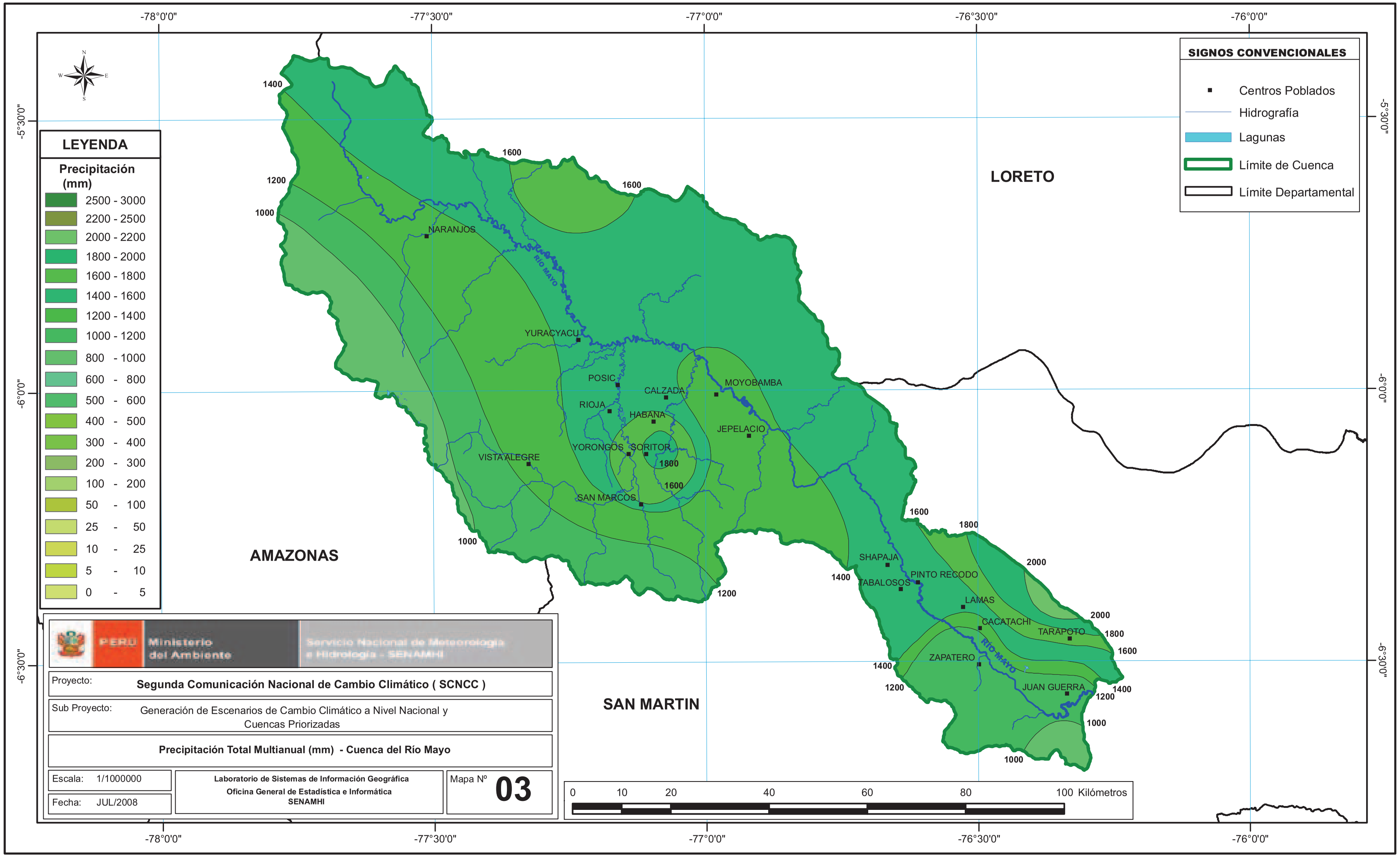
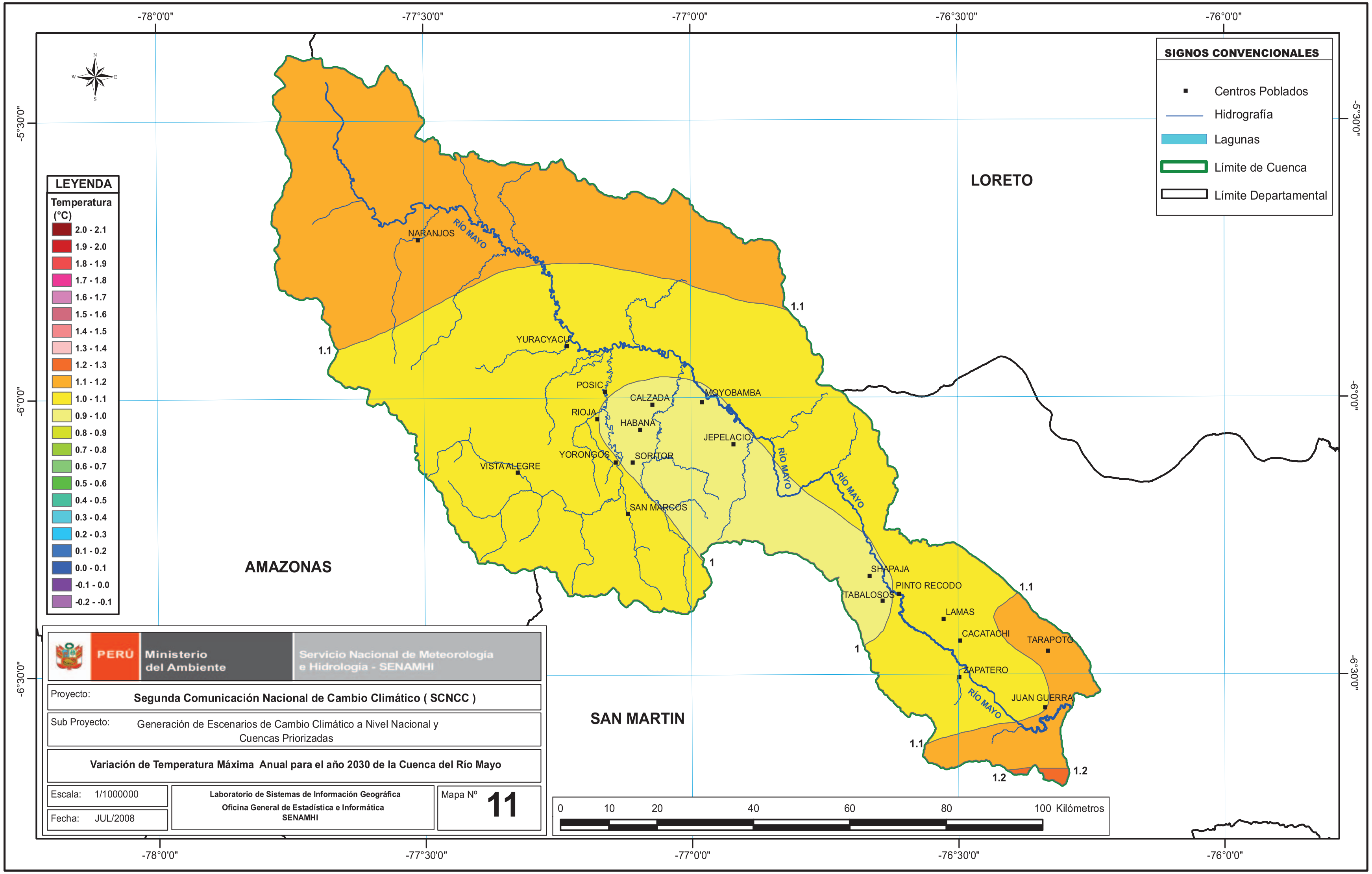
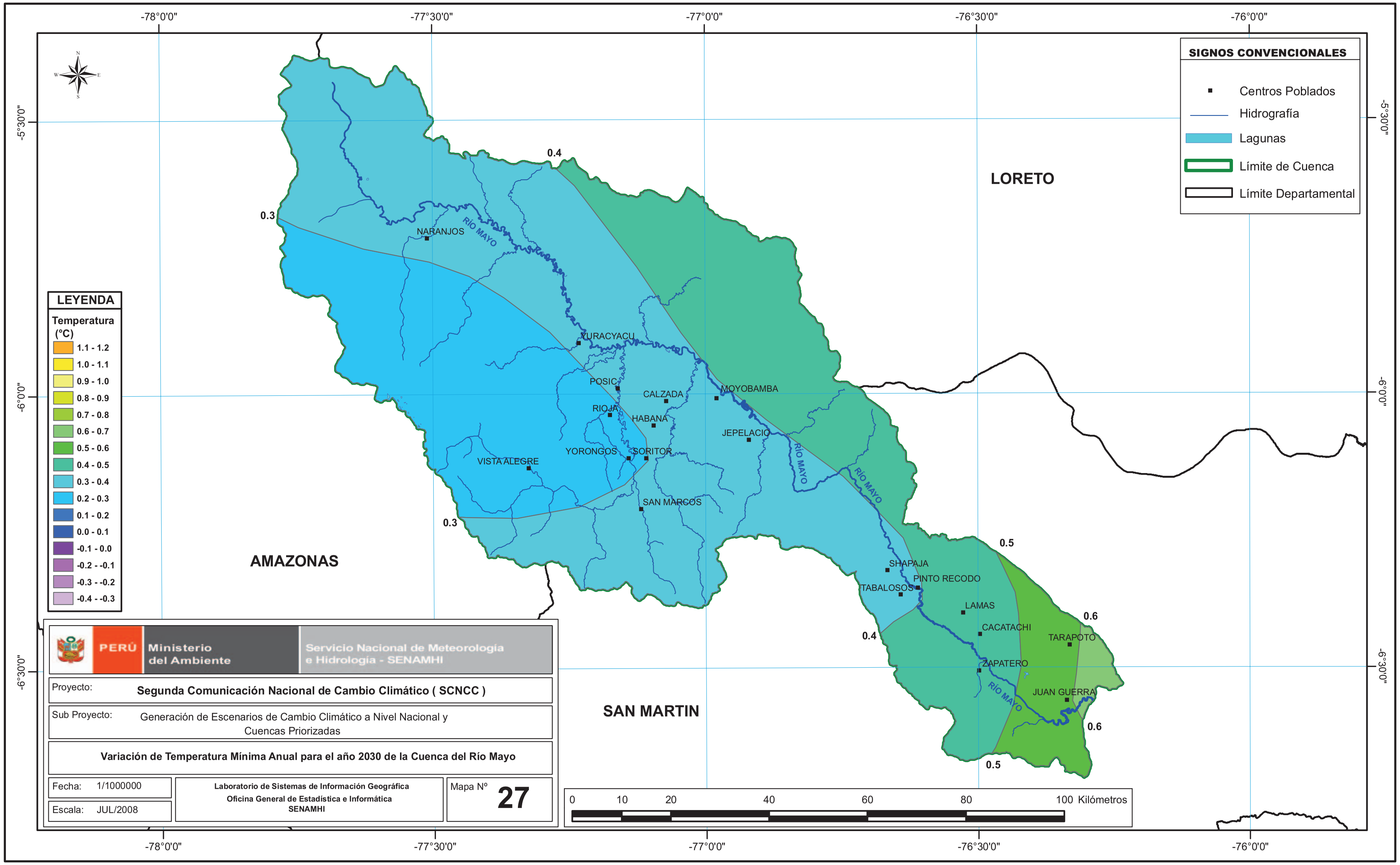
-76°0'0"
-5°30'0"
-6°0'0"
-6°30'0"
LEYENDA
Temperatura (°C)
24 - 26
22 - 24
20 - 22
18 - 20
16 - 18
14 - 16
12 - 14
10 - 12
8 - 10
6 - 8
4 - 6
2 - 4
0 - 2
-2 - 0
-4 - -2
SIGNOS CONVENCIONALES
Centros Poblados
Hidrografía
Lagunas
Límite de Cuenca
Límite Departamental
LORETO
AMAZONAS
SAN MARTIN
NARANJOS
YURACYACU
POSIC
RIOJA
CALZADA
HABANA
MOYOBAMBA
JEPELACIO
YORONGOS
SORITOR
VISTA ALEGRE
SAN MARCOS
SHAPAJA
PINTO RECODO
TABALOSOS
LAMAS
CACATACHI
TARAPOTO
ZAPATERO
JUAN GUERRA
PERU Ministerio del Ambiente
Servicio Nacional de Meteorología e Hidrología - SENAMHI
Proyecto: Segunda Comunicación Nacional de Cambio Climático (SCNCC)
Sub Proyecto: Generación de Escenarios de Cambio Climático a Nivel Nacional y Cuencas Priorizadas
Temperatura Mínima Promedio Multianual (°C) - Cuenca del Río Mayo
Escala: 1/1000000
Fecha: JUL/2008
Laboratorio de Sistemas de Información Geográfica
Oficina General de Estadística e Informática
SENAMHI
Mapa N° 02
0 10 20 40 60 80 100 Kilómetros

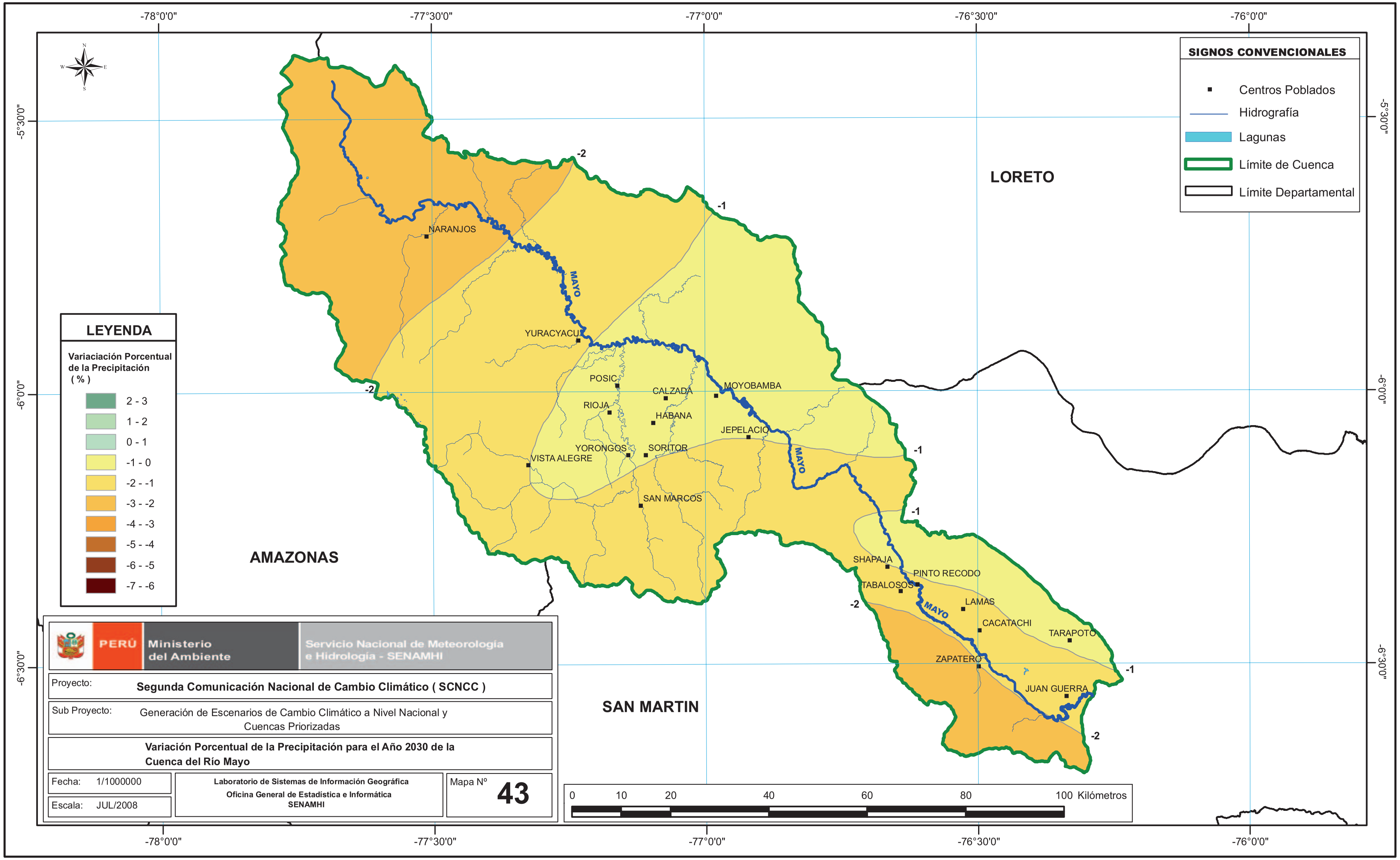


LEYENDA
Precipitación (mm)
2500 - 3000
2200 - 2500
2000 - 2200
1800 - 2000
1600 - 1800
1400 - 1600
1200 - 1400
1000 - 1200
800 - 1000
600 - 800
500 - 600
400 - 500
300 - 400
200 - 300
100 - 200
50 - 100
25 - 50
10 - 25
5 - 10
0 - 5
SIGNOS CONVENCIONALES
Centros Poblados
Hidrografía
Lagunas
Límite de Cuenca
Límite Departamental
LORETO
AMAZONAS
SAN MARTIN
NARANJOS
YURACYACU
POSIC
RIOJA
CALZADA
HABANA
YORONGOS
SORITOR
MOYOBAMBA
JEPELACIO
VISTA ALEGRE
SAN MARCOS
SHAPAJA
TABALOSOS
PINTO RECODO
LAMAS
CACATACHI
TARAPOTO
ZAPATERO
JUAN GUERRA
RIO MAYO
-78°0'0"
-77°30'0"
-77°0'0"
-76°30'0"
-76°0'0"
-5°30'0"
-6°0'0"
-6°30'0"
0 10 20 40 60 80 100 Kilómetros
PERU Ministerio del Ambiente
Servicio Nacional de Meteorología e Hidrología - SENAMHI
Proyecto: Segunda Comunicación Nacional de Cambio Climático (SCNCC)
Sub Proyecto: Generación de Escenarios de Cambio Climático a Nivel Nacional y Cuencas Priorizadas
Precipitación Total Multianual (mm) - Cuenca del Río Mayo
Escala: 1/1000000
Fecha: JUL/2008
Laboratorio de Sistemas de Información Geográfica
Oficina General de Estadística e Informática
SENAMHI
Mapa N° 03


-78°0'0"
-77°30'0"
-77°0'0"
-76°30'0"
-76°0'0"
-5°30'0"
-6°0'0"
-6°30'0"
LEYENDA
Temperatura (°C)
2.0 - 2.1
1.9 - 2.0
1.8 - 1.9
1.7 - 1.8
1.6 - 1.7
1.5 - 1.6
1.4 - 1.5
1.3 - 1.4
1.2 - 1.3
1.1 - 1.2
1.0 - 1.1
0.9 - 1.0
0.8 - 0.9
0.7 - 0.8
0.6 - 0.7
0.5 - 0.6
0.4 - 0.5
0.3 - 0.4
0.2 - 0.3
0.1 - 0.2
0.0 - 0.1
-0.1 - 0.0
-0.2 - -0.1
SIGNOS CONVENCIONALES
Centros Poblados
Hidrografía
Lagunas
Límite de Cuenca
Límite Departamental
LORETO
AMAZONAS
SAN MARTIN
NARANJOS
RÍO MAYO
YURACYACU
POSIC
RIOJA
CALZADA
HABANA
MOYOBAMBA
JEPELACIO
YORONGOS
SORITOR
VISTA ALEGRE
SAN MARCOS
SHAPAJA
PINTO RECODO
TABALOSOS
LAMAS
CACATACHI
TARAPOTO
ZAPATERO
JUAN GUERRA
1.1
1
1.2
PERÚ Ministerio del Ambiente
Servicio Nacional de Meteorología e Hidrología - SENAMHI
Proyecto: Segunda Comunicación Nacional de Cambio Climático (SCNCC)
Sub Proyecto: Generación de Escenarios de Cambio Climático a Nivel Nacional y Cuencas Priorizadas
Variación de Temperatura Máxima Anual para el año 2030 de la Cuenca del Río Mayo
Escala: 1/1000000
Fecha: JUL/2008
Laboratorio de Sistemas de Información Geográfica
Oficina General de Estadística e Informática
SENAMHI
Mapa Nº 11
0 10 20 40 60 80 100 Kilómetros



SIGNOS CONVENCIONALES
Centros Poblados
Hidrografía
Lagunas
Límite de Cuenca
Límite Departamental
LORETO
AMAZONAS
SAN MARTIN
LEYENDA
Temperatura (°C)
1.1 - 1.2
1.0 - 1.1
0.9 - 1.0
0.8 - 0.9
0.7 - 0.8
0.6 - 0.7
0.5 - 0.6
0.4 - 0.5
0.3 - 0.4
0.2 - 0.3
0.1 - 0.2
0.0 - 0.1
-0.1 - 0.0
-0.2 - -0.1
-0.3 - -0.2
-0.4 - -0.3
NARANJOS
RÍO MAYO
YURACYACU
POSIC
CALZADA
MOYOBAMBA
RIOJA
HABANA
JEPELACIO
YORONGOS
SORITOR
VISTA ALEGRE
SAN MARCOS
SHAPAJA
PINTO RECODO
TABALOSOS
LAMAS
CACATACHI
TARAPOTO
ZAPATERO
JUAN GUERRA
0.3
0.4
0.5
0.6
-78°0'0"
-77°30'0"
-77°0'0"
-76°30'0"
-76°0'0"
-5°30'0"
-6°0'0"
-6°30'0"
0 10 20 40 60 80 100 Kilómetros
PERÚ Ministerio del Ambiente
Servicio Nacional de Meteorología e Hidrología - SENAMHI
Proyecto: Segunda Comunicación Nacional de Cambio Climático (SCNCC)
Sub Proyecto: Generación de Escenarios de Cambio Climático a Nivel Nacional y Cuencas Priorizadas
Variación de Temperatura Mínima Anual para el año 2030 de la Cuenca del Río Mayo
Fecha: 1/1000000
Escala: JUL/2008
Laboratorio de Sistemas de Información Geográfica
Oficina General de Estadística e Informática
SENAMHI
Mapa N° 27



LEYENDA
Variación Porcentual de la Precipitación (%)
2 - 3
1 - 2
0 - 1
-1 - 0
-2 - -1
-3 - -2
-4 - -3
-5 - -4
-6 - -5
-7 - -6
SIGNOS CONVENCIONALES
Centros Poblados
Hidrografía
Lagunas
Límite de Cuenca
Límite Departamental
LORETO
AMAZONAS
SAN MARTIN
MAYO
NARANJOS
YURACYACU
POSIC
RIOJA
CALZADA
HABANA
MOYOBAMBA
JEPELACIO
YORONGOS
SORITOR
VISTA ALEGRE
SAN MARCOS
SHAPAJA
PINTO RECODO
TABALOSOS
LAMAS
CACATACHI
TARAPOTO
ZAPATERO
JUAN GUERRA
-78°0'0"
-77°30'0"
-77°0'0"
-76°30'0"
-76°0'0"
-5°30'0"
-6°0'0"
-6°30'0"
0 10 20 40 60 80 100 Kilómetros
PERÚ Ministerio del Ambiente
Servicio Nacional de Meteorología e Hidrología - SENAMHI
Proyecto: Segunda Comunicación Nacional de Cambio Climático (SCNCC)
Sub Proyecto: Generación de Escenarios de Cambio Climático a Nivel Nacional y Cuencas Priorizadas
Variación Porcentual de la Precipitación para el Año 2030 de la Cuenca del Río Mayo
Fecha: 1/1000000
Escala: JUL/2008
Laboratorio de Sistemas de Información Geográfica
Oficina General de Estadística e Informática
SENAMHI
Mapa N° 43

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