Global Water Monitor & Forecast Watch List

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Introduction

The ISciences Water Security Indicator Model (WSIM) monitors and forecasts water anomalies on a global basis. Each month we produce data and a report that document current conditions and provide forecasts with lead times from 1-9 months. WSIM has been run continuously since April 2011 and has been validated against subsequently observed data.

ISciences also provides assessments of the impacts of water anomalies on people, agriculture, and electricity generation. Detailed data and reports are available for purchase. Additional information and pricing are available upon request.

We have recently completed the latest Water Security Indicator Model (WSIM) analysis of global water anomalies using observed temperature and precipitation through August 2019 and an ensemble of forecasts issued the last week of August 2019. This edition of *Global Water Monitor & Forecast Watch List* presents a selection of regions likely to encounter significant water anomalies in the next few months. This report uses results from WSIM Version 2. In Version 2, WSIM has been re-engineered to be more computationally efficient and uses revised methodology for calculating composite water anomalies. Our blog post "Introducing WSIMv2" explains these and other improvements. In addition, WSIM is now available as an open source product. Visit https://wsim.isciences.com for details.

All maps have half-degree resolution and depict our composite water anomaly index, which is based on WSIM estimates of soil moisture, evapotranspiration deficit, runoff, and total blue water anomalies. Shades of red indicate deficits and shades of blue indicate surpluses. Since different variables are used to estimate deficits and surpluses, it is possible for a single half-degree cell to register both a deficit and a surplus in a given month. These cases are depicted on the maps in shades of purple, with the more extreme value (deficit or surplus) used to determine the shade.

Deficits and surpluses are stated in terms of return period – a measure that characterizes the rarity of an anomaly. For example, a return period of 10 years indicates an anomaly that would occur, on average, once every ten years. Higher return periods indicate more extreme and, therefore, more disruptive anomalies. Anomaly levels correspond to return periods: abnormal=3-5 years, moderate=5-10 years, severe=10-20 years, extreme=20-40 years, and exceptional=greater than 40 years. Return period is computed by comparison to cell-specific distributions of data from 1950 through 2009.

Please note that the WSIM model makes use of seasonal temperature and precipitation forecasts produced by the U.S. National Oceanic and Atmospheric Administration (NOAA) Climate Forecast System Version 2 (CFSv2). These forecasts predict broad temperature and precipitation patterns, but do not effectively predict singular events such as tropical storms. Detailed outlooks and analyses of tropical storms are available from the NOAA National Hurricane Center.

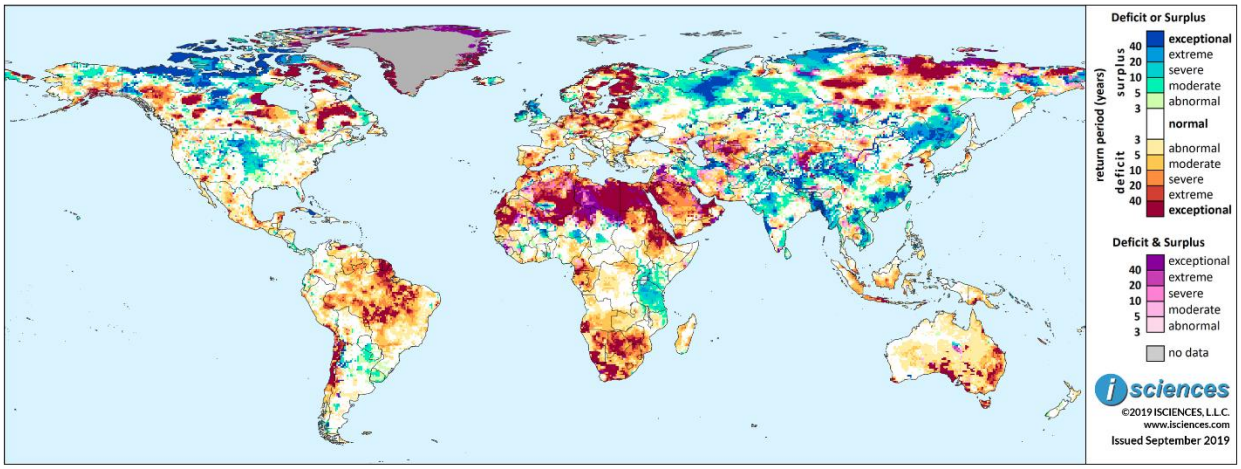
There are numerous regions around the world where country borders are contested. ISciences depicts country boundaries on these maps solely to provide some geographic context. The boundaries are nominal, not legal, descriptions of each entity. The use of these boundaries does not imply any

judgement on the legal status of any territory, or any endorsement or acceptance of disputed boundaries on the part of ISciences or our data providers.

Worldwide Water Watch List

This map presents a selection of regions likely to encounter significant water anomalies during the one-year period beginning in June 2019 and running through May 2020 using 3 months of observed temperature and precipitation data and 9 months of forecast data.

ISciences Water Anomalies Forecast: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

Watch List: Regional Synopsis

This synopsis provides highlights of regional water forecasts. More detailed analysis is available in "Watch List: Regional Details" immediately following the synopsis.

United States: Widespread water surpluses observed in prior months will shrink through November. However, a broad column of surplus is forecast from southern North Dakota reaching into north-central Texas with intense anomalies in South Dakota. Other areas of surplus include eastern Nevada into western Utah, Wyoming, and California from San Francisco through the southwest. A pocket of exceptional deficit is expected in the central Everglades.

Canada: The forecast through November indicates some moderate water deficits around Montreal and between Toronto and Ottawa, and severe deficits southeast of Winnipeg. A vast arc of exceptional deficit will persist in northern Quebec from Lake Mistassini to the province's eastern border. Intense deficits will also persist in central and northeastern Manitoba and central and northwestern Alberta. Surpluses are forecast from north-central Alberta into northwestern Manitoba.

Mexico, Central America, and the Caribbean: The forecast through November indicates that normal water conditions will return to much of Mexico but intense deficits will persist around the Gulf of Campeche. Extreme deficits are expected in southern Belize, moderate surpluses in Costa Rica, and intense surpluses in the Bahamas and central Cuba.

South America: The forecast through November indicates that, while water deficits will continue to dominate much of the northern bulk of the continent, the extent of exceptional deficit will diminish. Moderate to severe deficits are forecast for the western Amazon Basin of Brazil and extreme to exceptional deficits in the eastern portion. Other areas of intense deficit include Pará, Maranhão, French Guiana, and northern Chile. Surpluses are forecast for central Paraguay, northern Argentina, Uruguay.

Europe: The forecast through November indicates that water deficits in Central and Eastern Europe will shrink and moderate overall, but intense deficits are forecast in Finland and around the Baltic Sea. Conditions in Mediterranean Europe are expected to be relatively normal. Surpluses are forecast for Ireland and northern United Kingdom, and northern European Russia.

Africa: The forecast through November indicates that water deficits will shrink and downgrade considerably, particularly in the south, where merely mild deficits are expected. Moderate to exceptional deficits are forecast across the north and along the southwest bank of the Red Sea. Surpluses will persist in pockets of the western Sahel, emerge in pockets around the Gulf of Guinea, and increase in East Africa around Tanzania.

Middle East: The forecast through November indicates that widespread, intense water surpluses will persist in the region from southeastern Turkey and northern Syria through northern Iraq into northwestern Iran, and along the southeastern shore of the Caspian Sea and the Iran-Turkmen border. Exceptional deficits are forecast to emerge in a vast block of central Saudi Arabia.

Central Asia and Russia: The forecast through November indicates that water surpluses will intensify in the Northern European Plain in Russia. Surpluses are forecast for the Ob River Basin and along the Yenisei River, but intense deficits are expected in the eastern Yenisei Basin. In southern Turkmenistan intense surpluses are forecast; surpluses are also expected in Kyrgyzstan, western Tajikistan, and eastern Uzbekistan.

South Asia: The forecast through November indicates that water deficits in India will nearly disappear, as areas of deficit normalize or transition to surplus. Surpluses will persist in a vast stretch from Gujarat through Rajasthan, increasing in Madhya Pradesh. Surpluses are also forecast from Mumbai into Karnataka, and for central Uttar Pradesh. Southern India and Sri Lanka will transition from deficit to surplus. Widespread surpluses will persist in central Afghanistan.

Southeast Asia and the Pacific: The forecast through November indicates that water surpluses will be the dominant anomaly in Southeast Asia, while deficits emerge in much of Malaysia and Indonesia. Deficits will be exceptional in Malaysia. Surpluses are expected to reach exceptional intensity on the Mekong River through eastern Cambodia. Thailand will transition from intense deficit to surpluses in the north and generally normal conditions in the south.

East Asia: The forecast through November indicates that water anomalies will shrink and downgrade in the region though surpluses will remain widespread in several vast areas of China including the southeast and northeast. Deficits will downgrade on the Shandong Peninsula, retreat from South Korea,

and persist in North Korea, especially around Pyongyang. Near-normal conditions will return to a vast extent across the middle of China and the south. Moderate surpluses will persist in Kyushu, Japan.

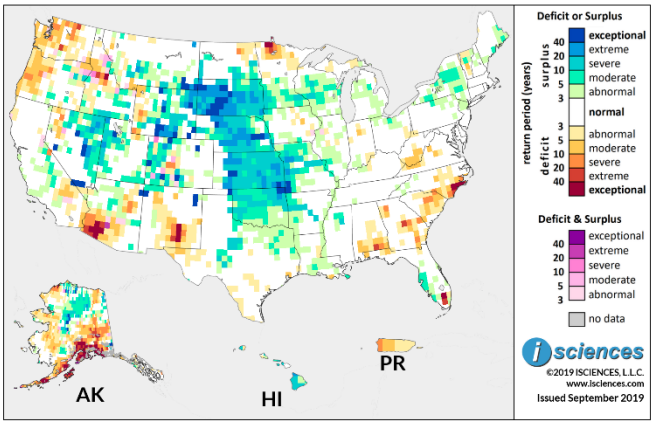
Australia & New Zealand: The forecast through November indicates severe to exceptional water deficits in eastern Australia from Rockhampton, Queensland to Melbourne, including the eastern Murray-Darling Basin. Deficits will shrink in Tasmania but will be severe. Nearly normal water conditions are expected in New Zealand. Severe to extreme deficits will persist in New Caledonia.

Watch List: Regional Details

United States

The 12-month forecast ending May 2020 indicates that water surpluses of varying intensity will form a column down the middle of the country in the Missouri River Basin from South Dakota through Kansas as well as in Oklahoma. Surpluses are expected to be extreme to exceptional in South Dakota; along the Platte River west of Omaha, Nebraska; and at the intersection of Kansas, Missouri, and Oklahoma.

ISciences Water Anomalies Forecast
United States: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

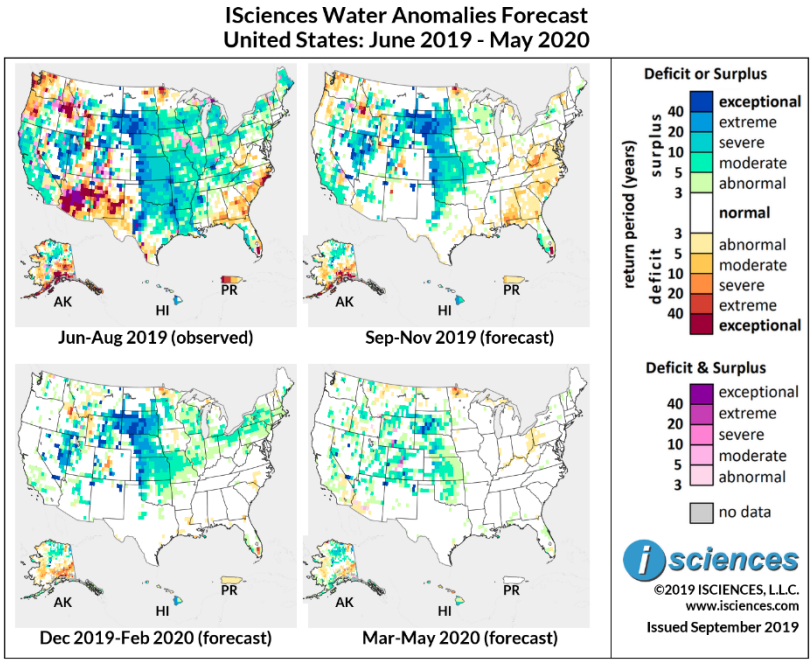
Severe surpluses are forecast along much of the Arkansas River, and from Kansas City to St. Louis along the Missouri River. Moderate to severe surpluses will reach across southern Minnesota through central Wisconsin. Texas, too, can expect surpluses in the western Edwards Plateau and in the northeast.

Surpluses are also forecast scattered throughout the Rockies and in eastern Nevada. Some moderate surpluses are expected in the southern Sierra Nevada Mountains in California. On the opposite side of the country, moderate surpluses are expected in Upstate New York and in the Tampa Bay region of Florida.

Deficits are forecast in the Pacific Northwest, southwestern Arizona, south-central New Mexico, north-central Minnesota, along the Atlantic coast from the Carolinas into pockets of Georgia and southern Alabama, and the central Everglades in Florida.

Outside the contiguous U.S., surpluses are forecast for much of Hawaii. In Alaska, surpluses are forecast in the Koyukuk River watershed. Deficits are forecast along the southern shore of the state from the Alaska Peninsula through Kodiak, Anchorage, and Valdez, and north to Fairbanks and the Tanana River region. Moderate to severe deficits are forecast for western Puerto Rico.

The 3-month maps (below) show the evolving conditions in more detail.



Based on observed data through August 2019 and forecasts through May 2020

From September through November 2019, widespread surpluses observed in prior months will shrink leaving nearly normal conditions in the U.S. Northeast, Ohio River Valley, Lower Mississippi River Basin and much of the Upper Mississippi River Basin. However, a broad column of intense water surplus is forecast from southern North Dakota through South Dakota, Nebraska, Kansas into Missouri, Oklahoma, and reaching into north-central Texas. Surpluses are expected to be extreme to exceptional in South Dakota. Surpluses of varying intensity are also forecast for parts of Montana, Wyoming, Colorado, southern Idaho, western Utah, and eastern Nevada.

Moderate surpluses are expected in central Arizona and in California around Sacramento, from San Francisco through the southwest, and in the southern Sierra Nevada Mountains. Some pockets of moderate surplus are forecast for central Oregon. Intense deficits are expected in the Salmon River Mountains of central Idaho. In the U.S. Southeast, mild to severe deficits will dapple the region from West Virginia through southern Alabama and into the Florida Panhandle. Surpluses are forecast near Tampa Bay, Florida, leading south along the coast. A pocket of exceptional deficit is expected in the central Everglades.

From December 2019 through February 2020, surpluses will be the dominant anomaly, persisting in a column from South Dakota into Oklahoma, and will be especially intense in South Dakota. Surpluses of varying intensity are forecast for Wyoming, western Utah, eastern Nevada, and pockets of southwestern Colorado. Moderate surpluses are also forecast in central Minnesota, pockets of Wisconsin and central Illinois, and throughout northern Missouri. Moderate surpluses will emerge in southeastern Michigan through northern Ohio and into northern Pennsylvania and Upstate New York. Small, isolated pockets of

deficit are forecast in the Salmon River Mountains of Idaho, central Colorado, northern Minnesota, and the central Everglades.

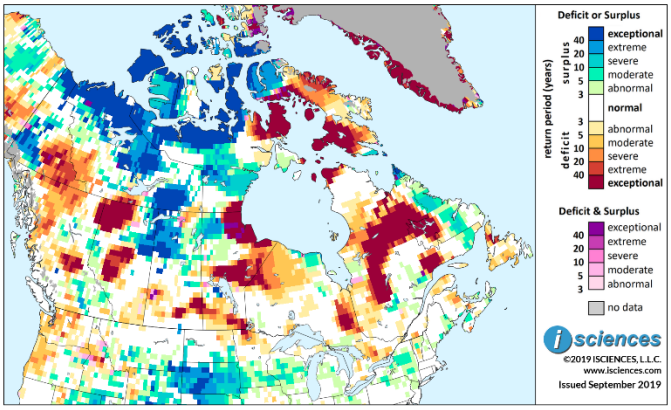
The forecast for the final months – March through May 2020 – indicates that a column of surplus will persist from South Dakota through Oklahoma but will shrink and downgrade overall in intensity. Exceptional surpluses will persist in South Dakota. Moderate surpluses are forecast scattered throughout the Rockies and some isolated pockets in the West.

(It should be noted that forecast skill declines with longer lead times.)

Canada

The 12-month outlook for Canada through May 2020 indicates a vast arc of exceptional water deficit in northern Quebec from Lake Mistassini curving northeast to the province's eastern border. Large pockets of intense deficit are also forecast for eastern and northwestern Ontario, central and northeastern Manitoba, central and northern Alberta, and central British Columbia.

ISciences Water Anomalies Forecast
Canada: June 2019 - May 2020

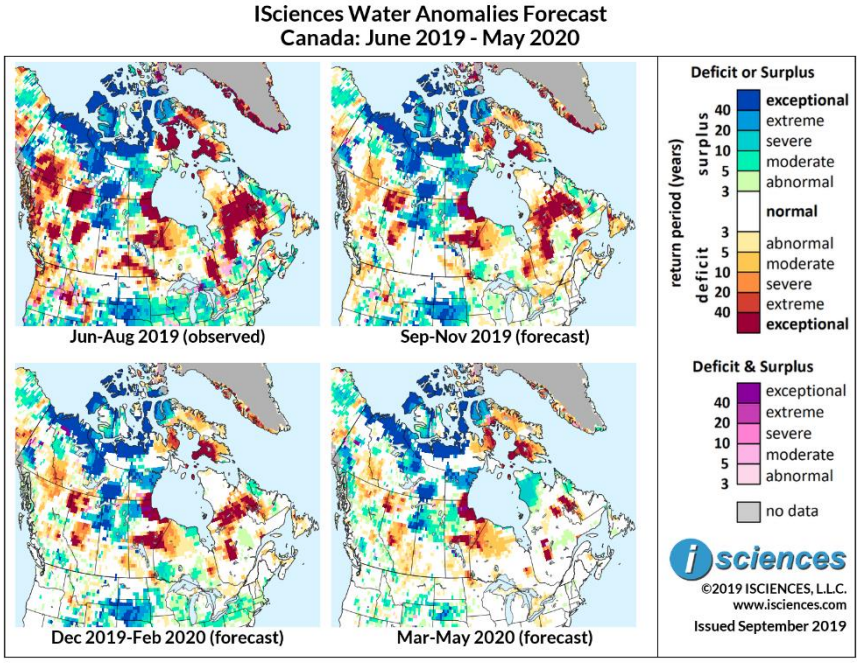


Based on observed data through August 2019 and forecasts through May 2020

A path of severe to exceptional deficits is forecast across southern Saskatchewan and Manitoba including the Assiniboine River Watershed, with exceptional deficits around Regina, Saskatchewan and Winnipeg, Manitoba.

A large block of intense surplus is forecast surrounding Fort McMurray, Alberta leading north past Lake Athabasca and east past Churchill Lake, Saskatchewan. Surpluses of generally lesser intensity are forecast southeast of Fort St. John in northern British Columbia and in the southern Columbia Mountains region of south-central British Columbia. At the opposite end of the country, surpluses are expected in eastern continental Newfoundland and Labrador, and in southern Quebec east of the Gouin Reservoir.

The 3-month maps (below) show the evolving conditions in more detail.



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November for major metropolitan areas of the nation, from east to west, includes normal conditions around Quebec City; some deficits around Montreal; moderate deficits between Toronto and Ottawa; moderate to extreme deficits southeast of Winnipeg; normal conditions in Regina Saskatoon, Calgary, and Edmonton; and near-normal conditions around Vancouver.

Areas of prior surplus in southern Quebec (QC) east of the Gatineau River will return to normal with some mild deficits. A vast arc of exceptional deficit will persist in northern QC from Lake Mistassini to the province's eastern border. Surpluses will shrink in eastern continental Newfoundland and Labrador (NL) but deficits are forecast for Newfoundland. Deficits will shrink but persist along Ontario's (ON) eastern border, and deficits will persist in the province's northwest quadrant. Moderate surpluses are expected in the northeastern ON on Hudson Bay, in the southwest, and spreading from the northeastern shore of Lake Superior.

In the Prairie Provinces, deficits of varying intensity are forecast for southern Manitoba (MB) and exceptional deficits in large blocks north of Lake Winnipeg and in the northeast along Hudson Bay. Surpluses will stretch from north-central Alberta (AB) through Fort St. McMurray and northern Saskatchewan (SK) into northwestern MB and will include exceptional anomalies. Intense deficits will persist in northwestern AB and in the Middle Reaches of the Athabasca River Watershed in the center of the province. In British Columbia (BC), surpluses are forecast in the southern Columbia Mountains, deficits at the meeting of the Nechako and Fraser Rivers in central BC, and in the north from Prince Rupert on the Pacific Coast northward across the border into Yukon.

From December 2019 through February 2020, the extent of deficits will diminish somewhat across the country as large blocks in aforementioned areas shrink. Areas of moderate deficit forecast in the prior

three months for southern QC and southern ON will normalize, and deficits in Newfoundland will diminish. Surpluses will persist in much the same distribution pattern as in the September through November forecast, increasing slightly in southern BC

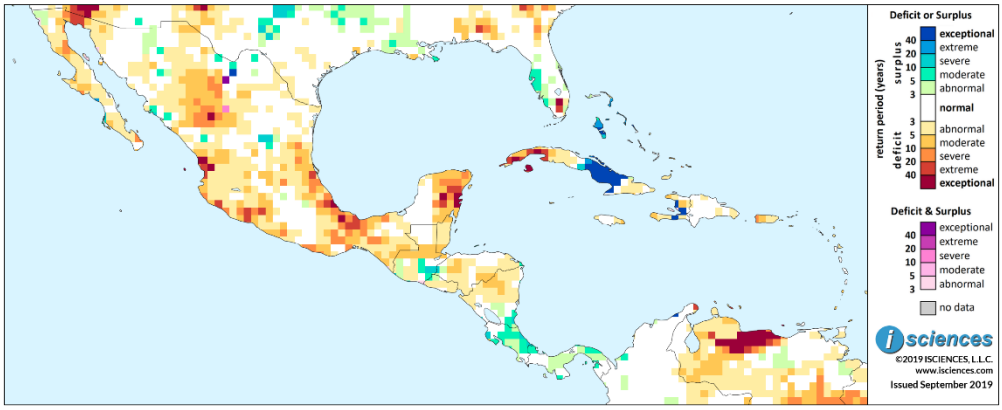
The forecast for the final three months – March through May 2020 – indicates that deficits will continue to shrink, surpluses will emerge in northern QC between Hudson Bay and Hudson Strait, areas of surplus in ON will return to normal, and surpluses will increase BC.

(It should be noted that forecast skill declines with longer lead times.)

Mexico, Central America, and the Caribbean

The 12-month forecast ending May 2020 indicates deficits of varying intensity in north-central Mexico, around the southern Gulf of Mexico reaching across the Isthmus of Tehuantepec to the Pacific, the eastern Yucatan Peninsula, and along the Pacific Coast from Nayarit to Acapulco.

ISciences Water Anomalies Forecast
Mexico, Central America, & the Caribbean: June 2019 - May 2020



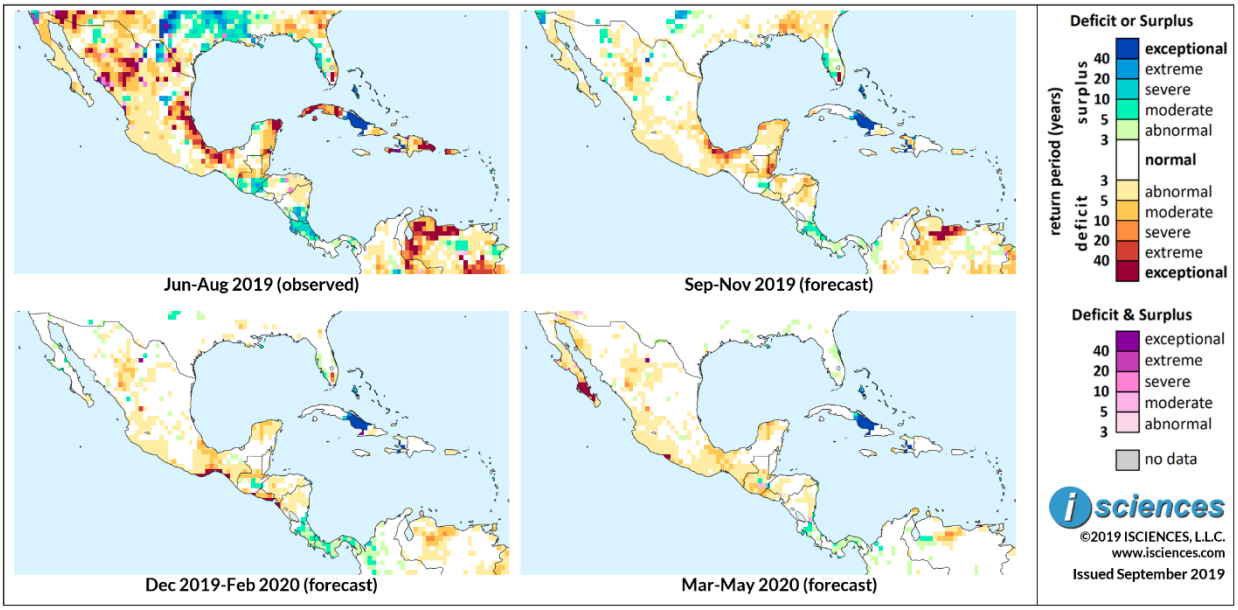
Based on observed data through August 2019 and forecasts through May 2020

Deficits could be extreme in central Durango in the north and exceptional in small pockets of Nayarit in the west and Quintana Roo in the Yucatan.

In Central America, moderate deficits are forecast in a band across central Guatemala and in pockets of Honduras and Nicaragua. Moderate surpluses are expected in southeastern Guatemala, the southeastern tip of Nicaragua, Costa Rica, and pockets of Panama. Cuba can expect intense deficits in the west and surpluses in the center of the nation. Extreme to exceptional surpluses are forecast for the Bahamas.

The 3-month maps (below) show the evolving conditions in more detail.

ISciences Water Anomalies Forecast
Mexico, Central America, & the Caribbean: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that deficits in Mexico will shrink and diminish, with normal water conditions returning to the bulk of the nation. Intense deficits will persist, however, around the Gulf of Campeche from the city of Veracruz around the southern shore of the Gulf. Deficits may be severe in a pocket around Merida in the Yucatan, and moderate to severe in the north along the border of Chihuahua and Durango. Moderate surpluses are expected nearby in Sonora between the Yaqui and Bavispe Rivers, and extreme surpluses will re-emerge in northwestern Baja southeast of Tijuana.

In Central America, extreme deficits are expected in southern Belize, and pockets of moderate deficit in central Guatemala, Honduras, and Nicaragua. Moderate surpluses are forecast east of Guatemala City and in Costa Rica. In the Caribbean, intense surpluses are expected in the Bahamas, central Cuba, and around Port-au-Prince, Haiti.

From December 2019 through February 2020, nearly normal conditions are expected throughout much of Mexico, Central America, and the Caribbean. Exceptional deficits are forecast along Mexico's Pacific Coast around the Gulf of Tehuantepec, but deficits near Veracruz around the Gulf of Campeche will shrink and moderate. Intense deficits are expected in southern El Salvador, and moderate surpluses in Costa Rica and Panama. Surpluses will remain intense in central Cuba and the Bahamas.

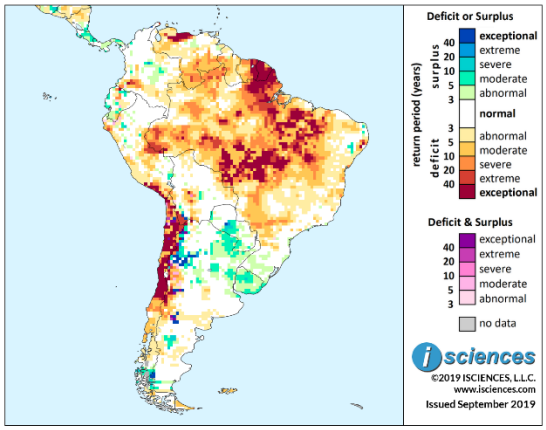
The forecast for the final three months – March through May 2020 – indicates that exceptional deficits will emerge in southern Baja; surpluses will diminish in Costa Rica and Panama but will persist in Central Cuba and the Bahamas.

(It should be noted that forecast skill declines with longer lead times.)

South America

The 12-month forecast through May 2020 indicates water deficits of varying intensity covering the bulk of Brazil; from Venezuela through French Guiana; and along the Pacific Coast from central Peru reaching south through the Atacama Desert to the beginning of Chilean Patagonia. Deficits will be intense in Suriname, French Guiana, and nearby regions of northern Brazil; Tocantins, Maranhão, Mato Grosso, and Acre, Brazil; northern Venezuela; and from southern coastal Peru to Santiago, Chile.

ISciences Water Anomalies Forecast
South America: June 2019 - May 2020



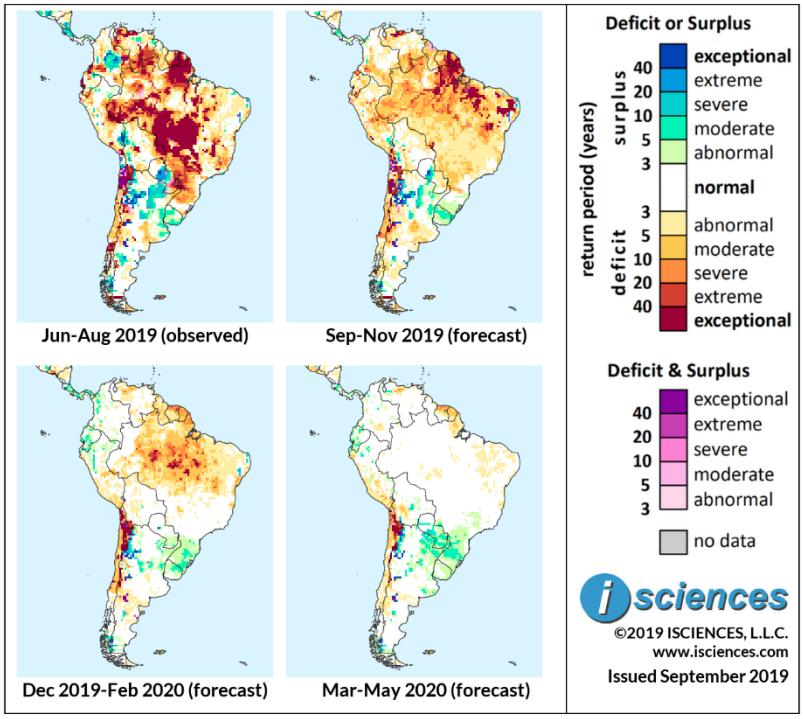
Based on observed data through August 2019 and forecasts through May 2020

Moderate to severe deficits are expected in southern Venezuela, with severe anomalies on the Caroni and Upper Orinoco Rivers. A pocket of intense deficit is forecast for southwestern Colombia, and moderate deficits are expected in central Peru.

Primarily moderate surpluses are forecast for central Paraguay and Argentina's northern provinces of Formosa, Chaco, Corrientes, Santa Fe, Córdoba, and Entre Ríos, and in Uruguay. More intense surpluses are expected in northwestern Argentina in Catamarca and La Rioja Provinces.

The 3-month maps (below) for the same 12-month period show the evolving conditions in greater detail.

ISciences Water Anomalies Forecast
South America: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates moderate to severe deficits in the western Amazon Basin of Brazil and extreme to exceptional deficits in the eastern portion of the Basin. Exceptional deficits are also forecast for eastern Pará into Maranhão, and Brazil's easternmost states. Deficits will be intense in French Guiana, severe in Suriname, and moderate in Guyana. Exceptional deficits will persist in a narrow strip of northern Venezuela including Caracas; moderate to extreme deficits are expected in the south. Deficits of varying intensity are forecast for southern Colombia, pockets of Ecuador, and much of Peru. Deficits will be intense in northern Chile, and moderate to occasionally exceptional south of the Atacama Desert to the Biobío River.

Surpluses will shrink but persist in central Paraguay, many provinces in northern Argentina, and along the border of Peru and Bolivia. Surpluses are also expected in Uruguay. Anomalies will be intense in central Paraguay and northwestern Argentina.

From December 2019 through February 2020, deficits will shrink considerably across the continent, leaving near-normal conditions in many regions. However, deficits ranging from moderate to extreme are forecast for the Amazon Basin in Brazil along with a few exceptional pockets in southern Pará. Generally moderate deficits are expected in Suriname and French Guiana. And, intense deficits will persist in northern Chile. Surpluses will nearly disappear in Paraguay, shrink in northern Argentina and Uruguay, and emerge in Rio Grande do Sul, Brazil's southernmost state. Moderate surpluses are also forecast in pockets of western Colombia, Ecuador, and northern Peru.

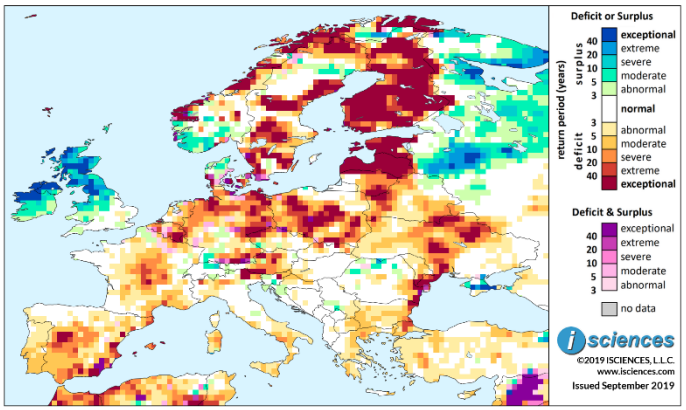
In the final quarter – March through May 2020 – normal conditions are forecast for much of the continent, notably Brazil. Intense deficits will persist in northern Chile and moderate deficits in Suriname and French Guiana. Surpluses are forecast for Paraguay, pockets of northern Argentina, and Rio Grande do Sul, Brazil.

(It should be noted that forecast skill declines with longer lead times.)

Europe

The 12-month forecast through May 2020 indicates water deficits of varying intensity in many regions of Europe from the Iberian Peninsula through Central Europe and around the Baltic Sea.

ISciences Water Anomalies Forecast
Europe: June 2019 - May 2020



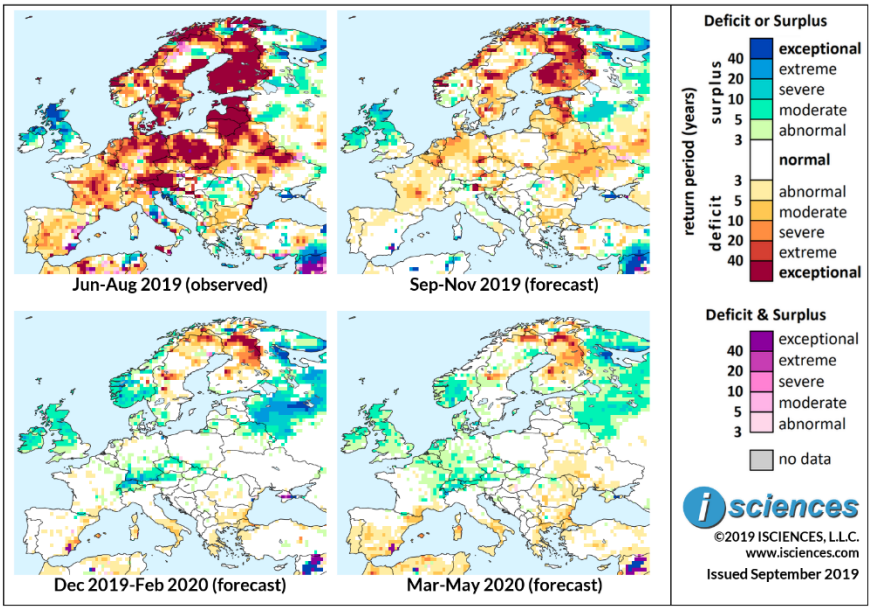
Based on observed data through August 2019 and forecasts through May 2020

Deficits will be widespread and exceptional in Finland, Estonia, and Latvia. Severe to exceptional deficits are forecast for Sweden, Poland, Germany, Belgium, Luxembourg, Austria, central Ukraine, along the western coast of the Black Sea, central France, and Spain.

Moderate to exceptional surpluses are expected in the northern United Kingdom and Ireland, and northern European Russia. Primarily moderate surpluses are forecast for southern Norway, northern Denmark, northern Switzerland, and pockets of northern Romania.

The 3-month composites (below) for the same 12-month time period show the evolving conditions.

ISciences Water Anomalies Forecast
Europe: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that deficits in Europe will shrink and downgrade overall, though deficits in Finland will remain widespread, ranging from severe to exceptional. Severe to

exceptional deficits will also persist in Estonia, Latvia, pockets of Sweden, and along the Norwegian Sea Coast. Isolated pockets of extreme deficit are forecast south of Kraków, Poland; the Ore Mountains in eastern Germany; from Munich, Germany into northwestern Austria; and the Dolomite Mountains in northeastern Italy. Moderate to severe deficits are forecast for Lithuania, Belarus, central and western Ukraine, northwestern Germany, Netherlands, Belgium, and central France. Moderate deficits will persist in western Bulgaria.

Moderate to extreme surpluses are forecast for Ireland and northern United Kingdom (UK). Surpluses of generally similar intensity are expected in northern European Russia, and deficits in southern European Russia.

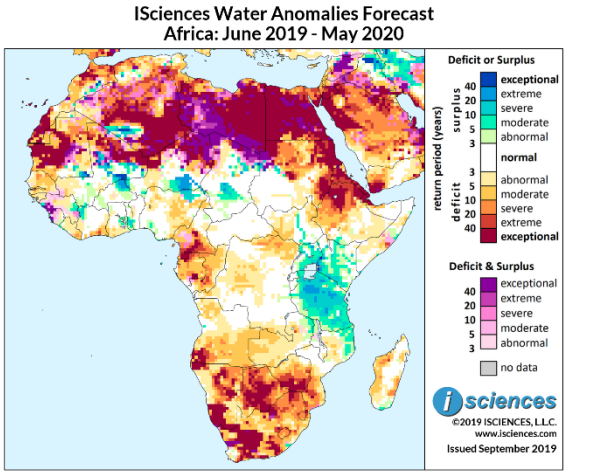
From December 2019 through February 2020, deficits will nearly disappear from Central and Eastern Europe, leaving much of the region in normal water conditions. Severe to exceptional deficits are forecast for northern Finland, though conditions in the south will normalize. Likewise, deficits in southern Sweden will nearly disappear while persisting in the center and northern sections of the nation. Some deficits will emerge south of Valencia, Spain. Surpluses will persist in Ireland and the northern UK and will emerge in southern Norway and pockets of southern Sweden, and from Switzerland through southern Germany into northern Austria, northern Czechia, and northern Slovakia. Surpluses will increase in northern European Russia and will include extreme to exceptional anomalies.

The forecast for the remaining months – March through May 2020 – indicates that surpluses will persist in southern Norway, shrink in Ireland and the northern UK, increase somewhat in pockets of Central Europe, and persist but moderate in northern European Russia. Deficits are forecast for northern Finland, central and northern Sweden, and scattered pockets around the Mediterranean.

(It should be noted that forecast skill declines with longer lead times.)

Africa

The 12-month forecast through May 2020 indicates intense water deficits across much of northern Africa and along the Red Sea. Deficits will be exceptional and widespread in Mauritania, Algeria, eastern Libya, Egypt, Eritrea, Djibouti, and the Ethiopian Highlands.

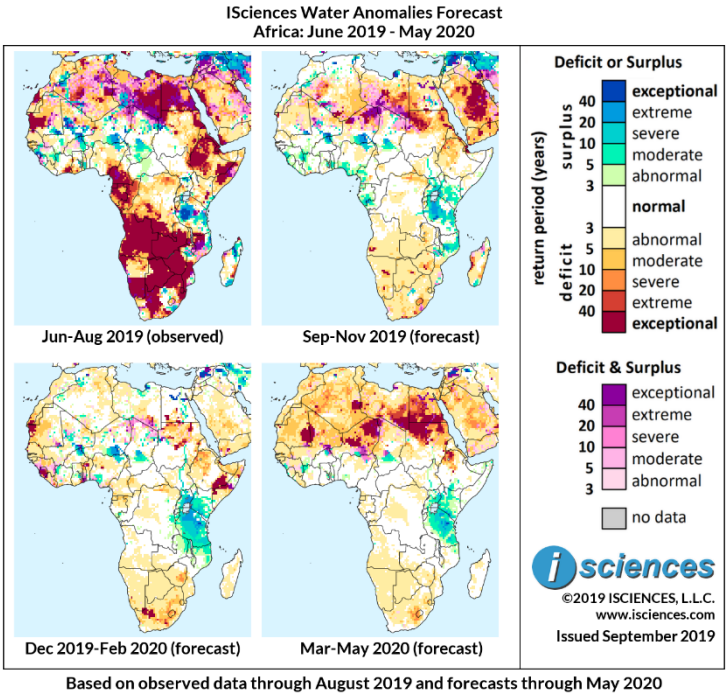


Based on observed data through August 2019 and forecasts through May 2020

Deficits of varying intensity are forecast for southern Africa, including large pockets of exceptional deficit in southwestern Angola, Namibia, Botswana, Zimbabwe, and South Africa. On the Gulf of Guinea, moderate to exceptional deficits are expected in Cameroon, Equatorial Guinea, Gabon, and Congo.

Widespread surpluses are forecast in East Africa including Uganda, Kenya, Tanzania, and northern Mozambique, and along the White Nile in South Sudan. Surpluses are expected to reach extreme intensity in central Tanzania. Surpluses are also forecast in pockets across the Sahel and scattered through a few nations on the northern shore of the Gulf of Guinea.

The 3-month maps (below) show the evolving conditions in greater detail.



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that deficits in Africa will shrink and downgrade considerably, particularly in the south, where merely mild deficits are expected with a few isolated patches of more intense anomalies. Moderate deficits are forecast across the north with some extensive pockets of severe to exceptional deficit in eastern Libya and northern Sudan. Deficits along the southwest bank of the Red Sea will shrink somewhat but intense pockets will persist. Deficits in the Horn will nearly disappear with some moderate to severe anomalies lingering in northern Ethiopia.

In East Africa, surpluses in Tanzania will downgrade slightly from exceptional anomalies observed in prior months but will be extreme in the west and moderate to severe in much of the rest of the nation. Primarily moderate surpluses will emerge in greater extent in the surrounding regions, including northern Mozambique, Kenya, Uganda, along the Lukuga River from Lake Tanganyika into Democratic Republic of the Congo, and along the White Nile through South Sudan. Surpluses are also forecast in pockets across the Sahel and scattered around the Gulf of Guinea from Guinea through Gabon, transitioning in Gulf nations from prior deficits that will nearly disappear.

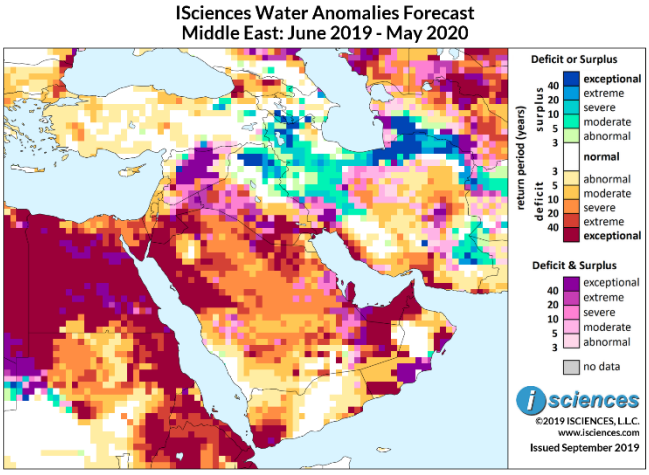
From December 2019 through February 2020, deficits will continue to shrink and downgrade, leaving nearly normal conditions in many parts of Africa. Intense deficits will, however, emerge from eastern Ethiopia into Somalia. Pockets of intense deficit are also forecast for Western Sahara, Mauritania, Sierra Leone, coastal Togo, northern Benin, northern Sudan, southwestern Egypt, and Northern Cape, South Africa. Moderate to severe deficits are expected in eastern South Africa, Lesotho, eastern Zimbabwe, and the Ethiopian Highlands. Moderate to extreme surpluses are forecast for Tanzania, northern Mozambique and Malawi, Kenya, Burundi, Uganda, and along the full length of the White Nile from Khartoum, Sudan. Pockets of surplus are also forecast in the western Sahel, northwest Côte d'Ivoire, Ghana west of Lake Volta, and coastal Nigeria.

During the final quarter – March through May 2020 – large pockets of intense deficit will emerge across northern Africa, particularly in Egypt, Sudan, and Libya. Widespread surpluses will persist in Tanzania and its northern neighbors.

(It should be noted that forecast skill declines with longer lead times.)

Middle East

The forecast for the 12-month period ending May 2020 indicates widespread water deficits of varying intensity covering much of the Arabian Peninsula including exceptional anomalies in Qatar, United Arab Emirates, southwestern Yemen, northwestern Saudi Arabia along the Red Sea, and southern Jordan.

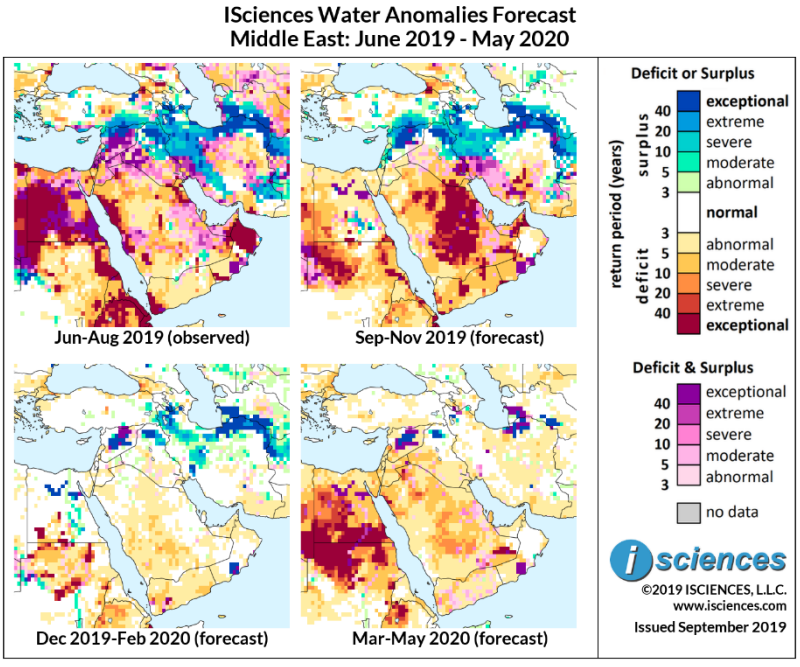


Based on observed data through August 2019 and forecasts through May 2020

Deficits are also forecast for central Iran, along Iran's Persian Gulf coast, and Georgia. Conditions of both deficit and surplus are expected in Syria and western Iraq. Some primarily moderate deficits are expected in pockets of Turkey, Cyprus, Lebanon, and the West Bank.

Surpluses are forecast from northern Iraq into western Iran, and in northern Iran along the southeastern Caspian Sea coast and the border with Turkmenistan. Surpluses are also forecast in southeastern Iran in the northern half of Sistan and Baluchestan Province. Areas of surplus include Mosul and Kirkuk in Iraq, and Tehran Iran. Surpluses will be extreme to exceptional along the Iran-Turkmen border; from Mosul to Kirkuk; and from Lake Urmia in northwestern Iran through the Nakhchivan Autonomous Republic of Azerbaijan and into southern Armenia.

The 3-month maps (below) show the evolving conditions in greater detail.



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that widespread surpluses will persist in the region from southeastern Turkey and northern Syria through northern Iraq into northwestern Iran, and along the southeastern shore of the Caspian Sea and the Iran-Turkmen border. Surpluses will remain intense, with exceptional anomalies persisting along the Iran-Turkmen border and around Mosul in Iraq, and re-emerging in northern Syria.

Exceptional deficits are forecast to emerge in a vast block of central Saudi Arabia including Riyadh, with deficits of lesser intensity covering much of the remainder of the Arabian Peninsula. Moderate deficits are forecast for Iraq west of the Euphrates River with some exceptional pockets in the south. Some pockets of exceptional deficit are also forecast for western Kerman Province in Iran. Moderate to severe deficits are expected in Georgia, with exceptional near Batumi on the Black Sea.

From December 2019 through February 2020, many parts of the region will return to normal water conditions as deficits shrink and downgrade considerably. Moderate to severe deficits will persist in western Georgia and some moderate pockets in the southeastern Arabian Peninsula. Areas of surplus will shrink as well but surpluses are forecast for central Syria, northern Iraq, western Iran, and the Iran-Turkmen border. Anomalies will be exceptional in the Iran-Turkmen border region, northern Iraq surrounding Mosul, and central Syria. Surpluses will re-emerge in Iran north of the Persian Gulf from western Isfahan Province into central Khuzestan Province.

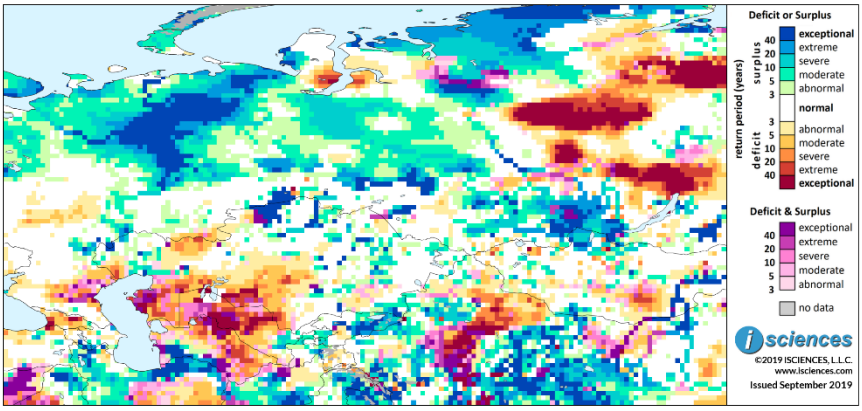
In the final quarter – March through May 2020 – surpluses will shrink considerably leaving some intense patches in central Syria, around Mosul, and in Iran near the southeastern coast of the Caspian Sea. Moderate to severe deficits will emerge in the Levant and increase in Saudi Arabia.

(It should be noted that forecast skill declines with longer lead times.)

Central Asia and Russia

The 12-month forecast through May 2020 indicates intense water surpluses along Turkmenistan's southern border, intense deficits in much of the remainder of the country as well as in Uzbekistan and across its border into western Kazakhstan.

ISciences Water Anomalies Forecast
Central Asia: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

Surpluses are expected in pockets of northern and eastern Kazakhstan and along portions of the Ishim and Esil Rivers. Surpluses are also forecast in eastern Kyrgyzstan, central Tajikistan, and eastern Uzbekistan.

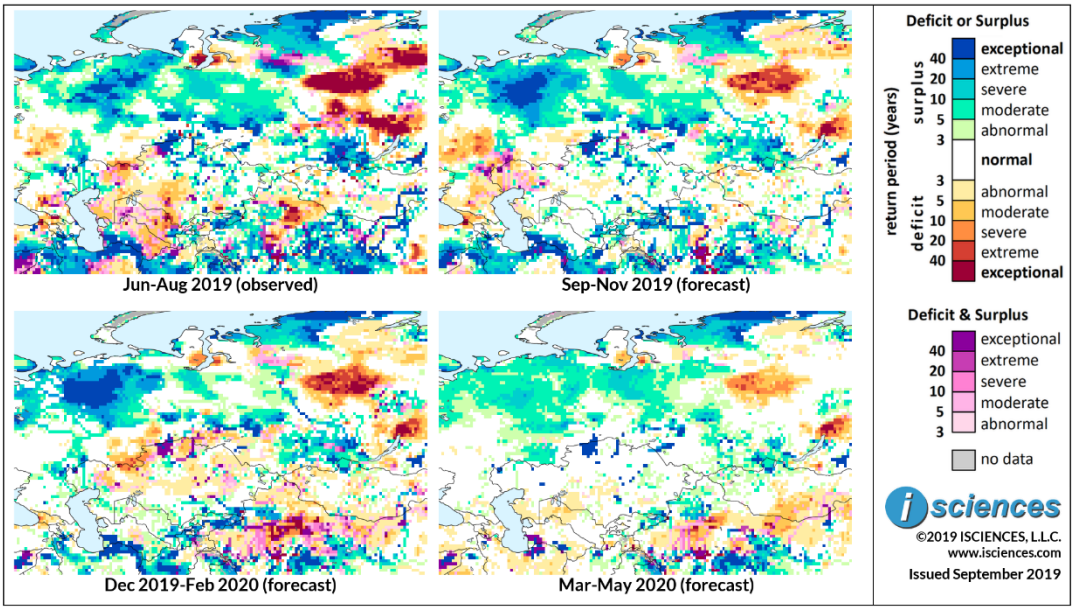
In Russia, surpluses are expected in the Northern European Plain and will be exceptional in the Vychegda Lowland. In the Volga River Basin, deficits are forecast in the Lower Volga region approaching the mouth of the river near the Caspian Sea, surpluses are forecast north of Volgograd and around Samara and Kazan, and moderate deficits in the Middle Volga region south of Nizhny Novgorod.

Surpluses are forecast for the Western Siberian Plain including the Ob and Vakh River Basins. Deficits are expected along the central coasts of the Gulf of Ob.

In the Yenisei River Basin, surpluses are forecast in the Lower Yenisei region, along much of the river itself, and in several oblasts west of Lake Baikal. Deficits are forecast in the Yenisei's eastern basin and will be intense in the region of the Nizhnyaya Tunguska and the Upper Reaches of the Podkamennaya Tunguska.

The 3-month composites (below) for the same 12-month period show the evolving conditions in more detail.

ISciences Water Anomalies Forecast
Central Asia: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that surpluses will intensify in the Northern European Plain in Russia with exceptional anomalies in the Vychegda Lowland. In the Volga River region, surpluses are forecast around the Kuybyshev Reservoir between Samara to Kazan, but deficits are forecast south of Nizhny Novgorod.

Widespread surpluses will persist in the Ob River Basin and will be intense west of the intersection of the Tobol, Irtysh, and Ob Rivers. Anomalies will also be intense in the Upper Ob region north of Novosibirsk. Intense deficits will persist along the central coasts of the Gulf of Ob.

Surpluses are forecast on the Yenisei River but deficits reaching exceptional intensity are expected in the regions of its eastern tributary, the Nizhnyaya Tunguska.

In Kazakhstan, surpluses will persist in pockets of the north, east, and in the south along the Ile and Syr Darya Rivers. Deficits in the west will diminish. Surpluses are forecast for Kyrgyzstan, western Tajikistan, eastern Uzbekistan and a pocket in the west, and in a wide band along Turkmenistan's southern border where surpluses will be extreme to exceptional.

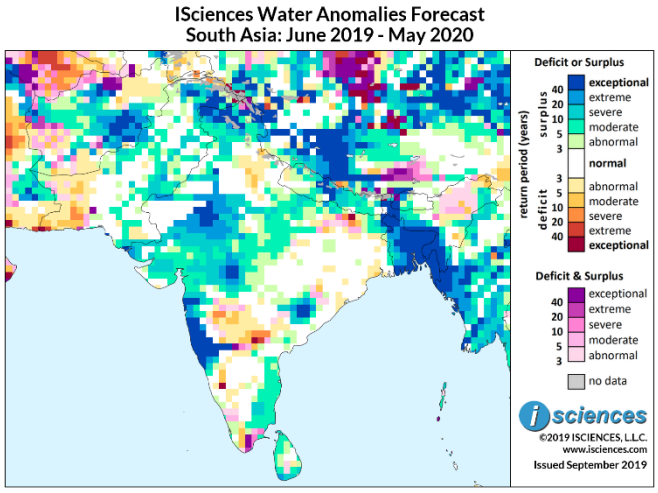
From December 2019 through February 2020, intense, widespread surpluses will persist in the Northern European Plain in Russia but will shrink somewhat in the Western Siberian Plain. Surpluses will persist on the Ob River and in several oblasts west of Lake Baikal. Deficits will persist along the central coasts of the Gulf of Ob, in the Nizhnyaya Tunguska River region, and north of Lake Baikal. Deficits will emerge in northern Kazakhstan, particularly in Aktobe Region and across its border into the Ural River region of Russia. Surpluses are forecast Kyrgyzstan, western Tajikistan, eastern Uzbekistan, and southern Turkmenistan. Deficits will disappear south of Nizhny Novgorod in Russia's Volga River Basin and in the Caucusus Region between the Black and Caspian Seas. Surpluses will emerge on the Lower Volga.

The forecast for the final months – March through May 2020 – indicates moderate to severe surpluses across the Northern European Plain and in the Western Siberian Plain, deficits along the central coasts of the Gulf of Ob and in western regions of the Central Siberian Plateau, and relatively normal conditions in Central Asia.

(It should be noted that forecast skill declines with longer lead times.)

South Asia

The 12-month forecast through May 2020 indicates water surpluses as the dominant anomaly in the region. Areas of exceptional surplus include much of Bangladesh; along India's western coast from north of Mumbai past Goa in the south, and central Rajasthan; and Ghazni Province in Afghanistan.



Based on observed data through August 2019 and forecasts through May 2020

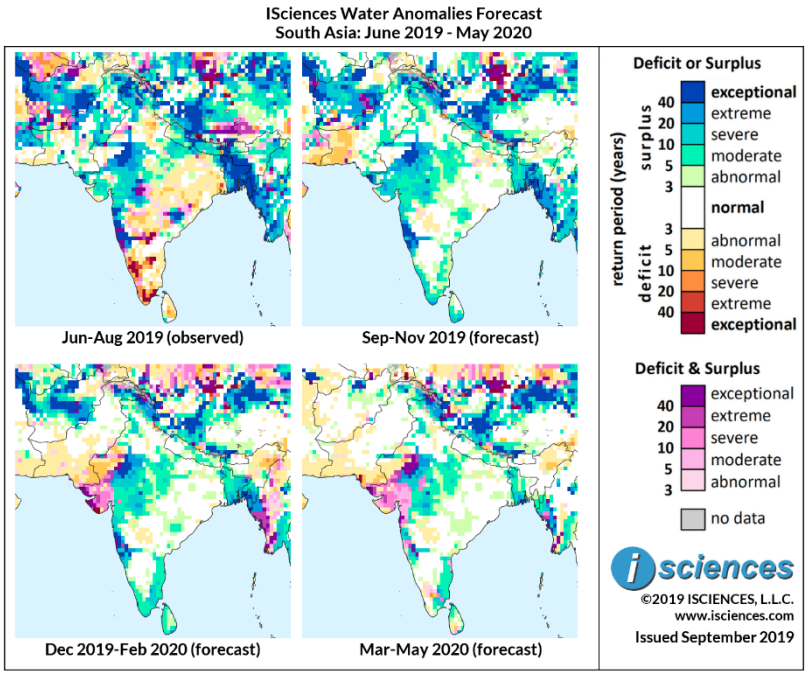
Surpluses will cover a vast expanse in India from Gujarat in the west leading northeast through Rajasthan and much of Madhya Pradesh into central Uttar Pradesh. Intense surpluses will follow the west coast, as previously mentioned, from Mumbai past Goa. Surpluses are also expected in India's far northern states, in southern Chhattisgarh and neighboring Odisha, and southern Andhra Pradesh through most of Tamil Nadu in the southeast. Deficits are forecast for Telangana around Hyderabad and nearby in southeastern Maharashtra.

In Pakistan, surpluses will be intense in the far north, and moderate to severe on the Afghan border and along the Indus, Jhelum, and Chenab Rivers. Deficits are expected in southwestern Pakistan.

In Afghanistan, surpluses reaching exceptional intensity are forecast from Kandahar to Kabul in the east and from Herat nearly to Mazar-e Sharif in the west. Surpluses of lesser intensity are forecast along parts of the Helmand River through the center of the country.

Surpluses are also expected in Nepal and western Bhutan.

The 3-month composites (below) show the evolving conditions in greater detail.



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that deficits in India will nearly disappear, returning many former areas of deficit to normal water conditions or surplus. Surpluses will persist in a vast stretch from Gujarat in the west through Rajasthan, increasing in Madhya Pradesh. Surpluses will be exceptional in central Rajasthan. Moderate to severe surpluses are forecast for central Uttar Pradesh. Surpluses will persist on the west coast from Mumbai into Karnataka and will include exceptional anomalies in southwestern Maharashtra. Southern India will transition from deficit to primarily moderate surplus in Kerala, Tamil Nadu, and into Sri Lanka. Moderate surpluses are expected from southern Chhattisgarh into Odisha. Surpluses in the far north will downgrade.

In Pakistan, surpluses will shrink along rivers in the east but will be severe on the northern portion of the Indus and extreme along the border with Afghanistan. Moderate deficits are expected to emerge in southwestern Pakistan. Widespread surpluses will persist in central Afghanistan, increasing somewhat as surpluses re-emerge. Anomalies will be exceptional around Mazar-e Sharif and south of Kabul.

Surpluses will shrink and downgrade in Nepal, leaving moderate anomalies, and surpluses will persist in western Bhutan. In Bangladesh, widespread surpluses will persist but will downgrade in most areas from exceptional to severe.

From December 2019 through February 2020, surpluses will persist in India in a pattern similar to the prior three months' forecast, with the exception that both deficits and surpluses (pink/purple) are forecast for Gujarat as transitions occur. Moderate deficits are forecast to emerge directly north in western Rajasthan. In southeastern India, moderate surpluses will increase; surpluses in Chhattisgarh will shrink somewhat. Some primarily moderate deficit anomalies will emerge in India's Far Northeast. In

Bangladesh, surpluses will remain widespread, but exceptional anomalies will downgrade. Conditions in central Pakistan will transition from surplus to normal, and deficits in the southwest will become merely mild. The extent of surplus in Afghanistan is expected to shrink somewhat but exceptional anomalies will increase in a band across the center of the nation.

The forecast for the final months – March through May 2020 – indicates nearly normal water conditions returning to Afghanistan and Pakistan, diminished surpluses in Bangladesh, and a pattern of surplus in India similar to the December through February forecast.

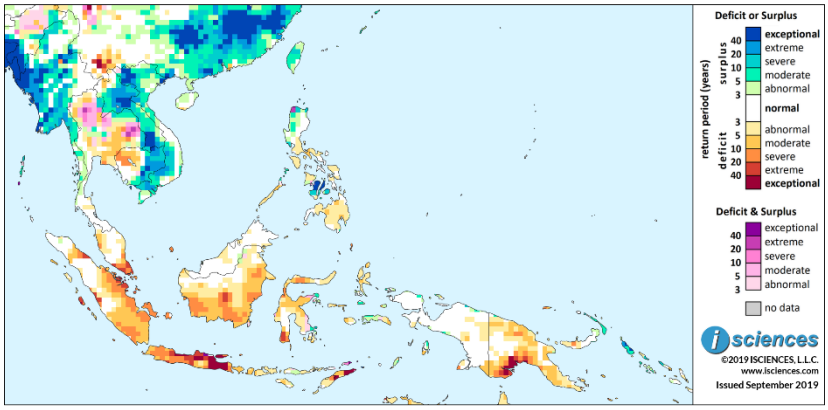
(It should be noted that forecast skill declines with longer lead times.)

Southeast Asia and the Pacific

The 12-month forecast through May 2020 indicates water deficits of varying intensity in Indonesia, the tip of peninsular Malaysia, Papua New Guinea, parts of Thailand, and northwestern Cambodia. Deficits will be intense in Java, East Timor, and along the western shore of the Gulf of Papua in Papua New Guinea.

Widespread surpluses are forecast for Myanmar, Laos, Vietnam and eastern Cambodia ranging from moderate to exceptional.

ISciences Water Anomalies Forecast
Southeast Asia: June 2019 - May 2020

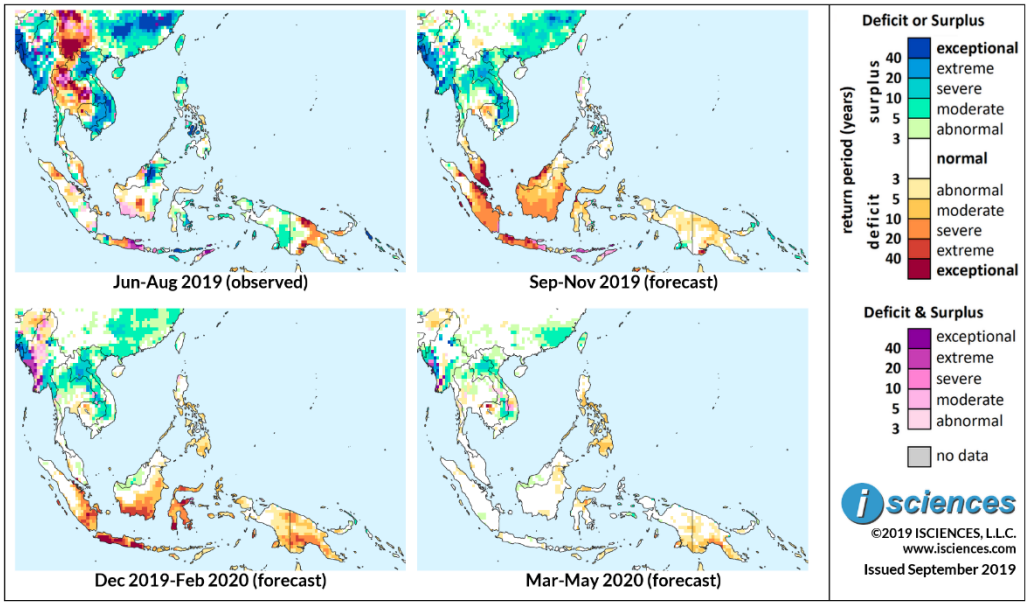


Based on observed data through August 2019 and forecasts through May 2020

Intense surpluses are forecast in central Philippines around Cebu, and surpluses of lesser intensity are expected in northern Luzon.

The 3-month maps (below) show the evolving conditions in more detail.

ISciences Water Anomalies Forecast
Southeast Asia: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that surpluses will be the dominant anomaly in Southeast Asia. Surpluses of varying intensity will persist in much of Myanmar and will be especially intense in the west. Moderate to extreme surpluses are forecast for Laos, eastern Cambodia, and Vietnam, though the

extent of surplus will diminish somewhat in Vietnam and Cambodia. Surpluses are expected to reach exceptional intensity on the Mekong River through eastern Cambodia. Thailand will transition from intense deficit to surpluses in the north and generally normal conditions in the south. Some moderate to severe deficits will linger in Cambodia north of Tonlé Sap.

Deficits will emerge throughout much of Malaysia and Indonesia and will be exceptional in Malaysia, and severe to extreme in southern Sumatra, Java, and Indonesian Borneo. Deficits in Papua New Guinea will moderate, but some intense deficits will persist on the southwestern shore of the Gulf of Papua. Surpluses will diminish in Papua, Indonesia and some mild deficits will emerge. Surpluses will diminish in the Philippines as well, but severe surpluses will persist in the central islands.

From December 2019 through February 2020, surpluses will persist but downgrade somewhat in Southeast Asia. Conditions of both deficit and surplus (pink/purple) are forecast for western Myanmar as transitions occur. Deficits in northwestern Cambodia will nearly disappear. Conditions in Malaysia will return to normal with some mild surpluses forecast for Malaysian Borneo. Deficits will shrink in Sumatra, and Indonesian Borneo but remain intense, and deficits in Java and Sulawesi will elevate in intensity, with exceptional anomalies forecast. Moderate to severe deficits will increase on New Guinea, particularly in Papua New Guinea. Surpluses in the central Philippines are expected to disappear and some mild deficits will emerge in the central islands and Mindanao.

The forecast for the final months – March through May 2020 – indicates nearly normal conditions in Malaysia and Indonesia, and some deficits in southern New Guinea and the Philippines. Surpluses are forecast in southern Myanmar, northern Laos into Vietnam, and pockets of eastern Cambodia and southern Vietnam but nearly normal conditions elsewhere in Southeast Asia.

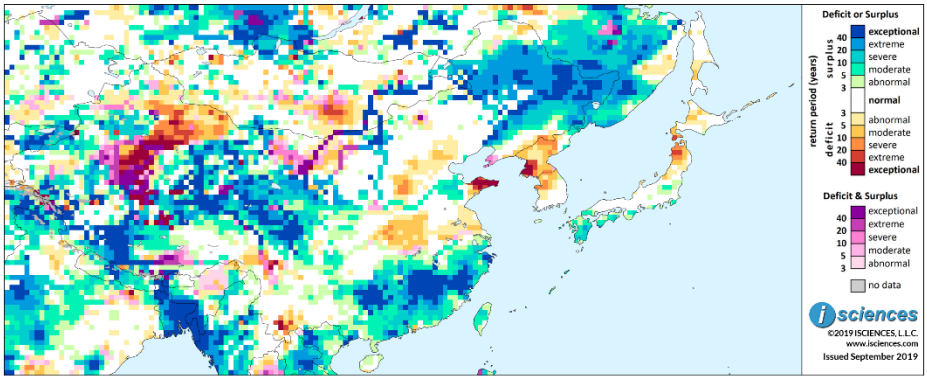
(It should be noted that forecast skill declines with longer lead times.)

East Asia

The 12-month forecast for East Asia through May 2020 indicates widespread, intense water surpluses in southeastern China including exceptional surpluses in Guangxi, Jiangxi, and Fujian.

Extreme to exceptional surpluses are forecast in Northeast China in Heilongjiang, Jilin, and Inner Mongolia Provinces.

ISciences Water Anomalies Forecast
East Asia: June 2019 - May 2020



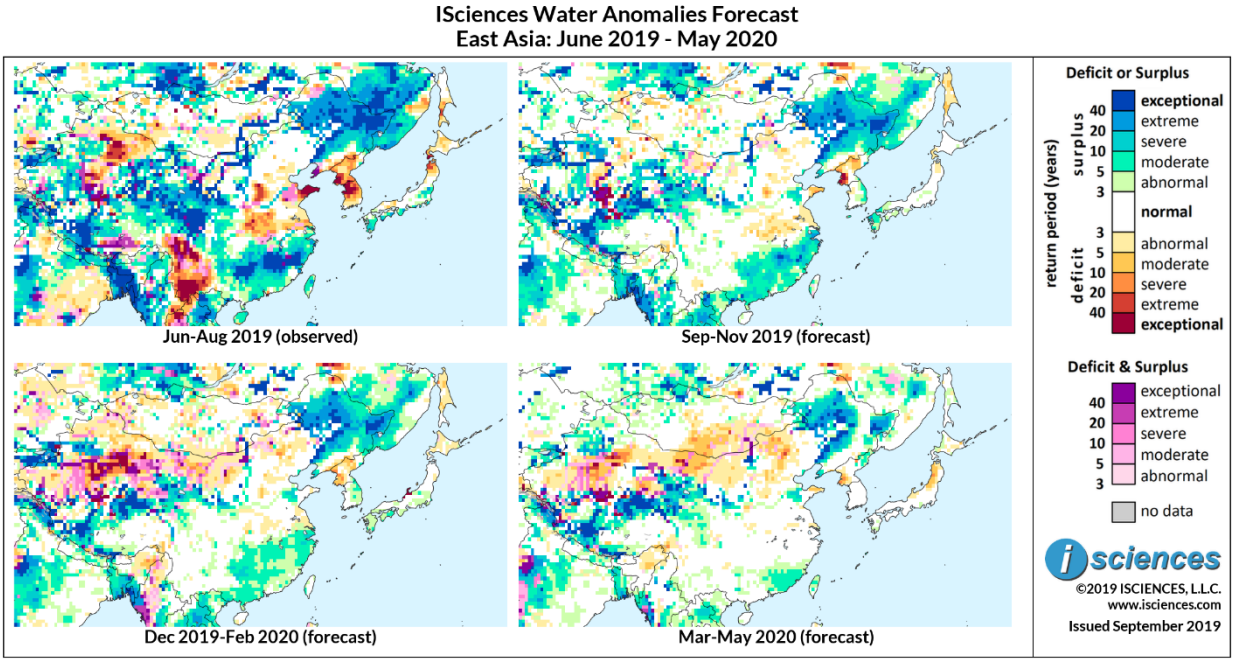
Based on observed data through August 2019 and forecasts through May 2020

Surpluses will also be widespread and intense in northwestern Sichuan, Qinghai, and western Tibet (Xizang). Moderate surpluses are expected along the Lower Reaches of the Yellow River (Huang He), and severe surpluses along the northward path of the Ordos Loop.

Intense deficits are expected in the Shandong Peninsula in the east. Intense deficits are also forecast for central and northeastern Xinjiang in western China, and in southern Yunnan. Primarily moderate deficits are expected in Hubei, Henan, Shanxi, and Beijing.

Deficits are forecast for the Korean Peninsula, particularly in North Korea, and could reach exceptional intensity around Pyongyang. In Japan, surpluses are forecast for Kyushu and Shikoku, and moderate to extreme deficits are expected from northernmost Honshu into Hokkaido.

The 3-month time series maps below show the evolving conditions in more detail.



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates that both deficit and surplus anomalies will shrink and downgrade in the region, though surpluses will remain widespread in several vast areas of China. Widespread surpluses will persist in southeastern China with generally moderate to severe anomalies expected and some pockets of greater intensity in central Jiangxi and around Shanghai. Surpluses of varying intensity are forecast in western China in many parts of Xinjiang, western Tibet, and Qinghai. And, severe to exceptional surpluses are expected to persist in several provinces of Northeast China including Heilongjiang, Jilin, Inner Mongolia, and Liaoning.

Surpluses will emerge in central Shandong Province, but moderate deficits are forecast for the Shandong Peninsula, downgrading from exceptional anomalies observed in the prior three months. Moderate deficits are also expected in eastern Shanxi, Hubei, and Anhui. Exceptional deficits are forecast in western China in the central Kunlun Mountains of Xinjiang.

Near-normal water conditions will return to a vast extent across the middle of the nation and the south, from central Tibet east through Chongqing and south through Yunnan, though surpluses on the Upper Reaches of the Yangtze River will dissect this normalcy.

Deficits will nearly disappear from South Korea and moderate surpluses will emerge along the eastern shore. In North Korea, however, deficits will persist, shrinking slightly, and will continue to be intense around Pyongyang. In Japan, moderate surpluses will persist in Kyushu and across the Shimonoseki Strait into the tip of Honshu. Relatively normal water conditions are expected in the rest of Japan.

From December 2019 through February 2020, widespread moderate surpluses will persist in southeastern China with conditions in some coastal provinces downgrading to merely mild anomalies. The Shandong Peninsula will transition from deficit to normal conditions, but moderate to severe

surpluses will persist in western Shandong Province. Widespread, intense surpluses will continue to dominate Northeast China. Surpluses of varying intensity are expected to persist from western Tibet through much of Qinghai and east through southern Gansu and central Shaanxi. Intense deficits will increase in eastern Xinjiang. On the Korean Peninsula, deficits will moderate in North Korea, and some pockets of surplus are forecast in South Korea. Moderate surpluses will emerge in eastern Shikoku, Japan, and exceptional deficits will emerge on Honshu's Noto Peninsula on the Sea of Japan.

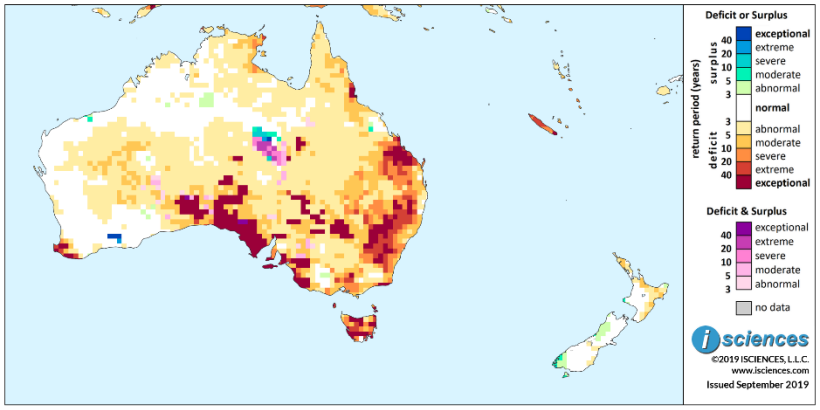
The forecast for the final three months – March through May 2020 – indicates that surpluses will shrink considerably in southeastern China and shrink somewhat in the northeast. Moderate deficits will emerge in southern Mongolia and Inner Mongolia, China, and in northwestern Honshu, Japan.

(It should be noted that forecast skill declines with longer lead times.)

Australia & New Zealand

The 12-month forecast through May 2020 indicates exceptional water deficits in South Australia, and deficits reaching exceptional intensity in a wide path along the eastern portion of the nation and in Tasmania.

ISciences Water Anomalies Forecast
Australia & New Zealand: June 2019 - May 2020



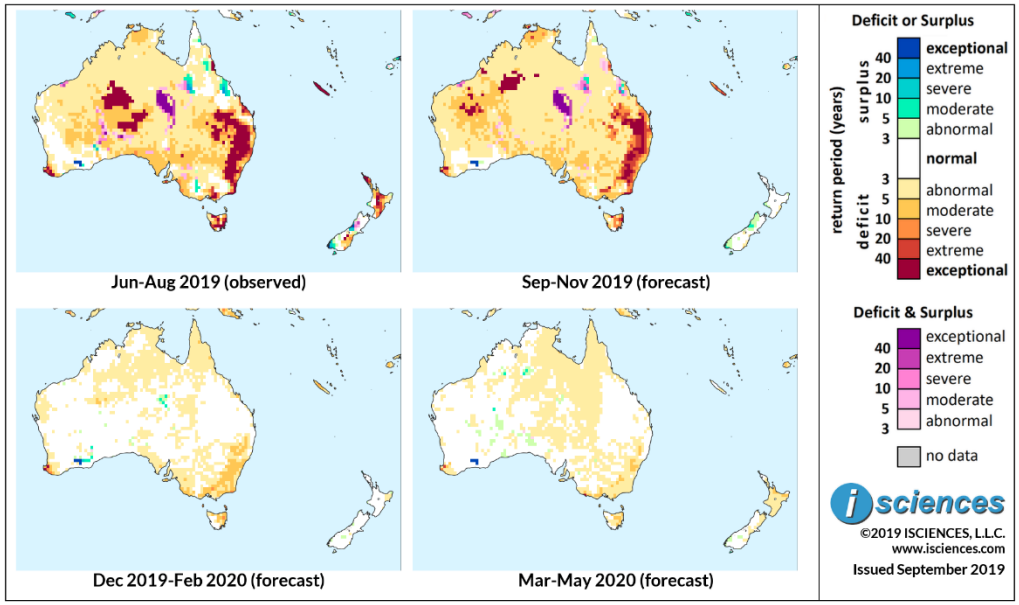
Based on observed data through August 2019 and forecasts through May 2020

Deficits will be exceptional near Adelaide, extreme around Canberra, and severe near Melbourne, Sydney, and Brisbane. Widespread, intense deficits are expected in the Murray-Darling Basin. Intense deficits are also forecast for Australia's southwestern tip around Busselton and the Blackwood River region.

Nearly normal conditions are expected in New Zealand, with some moderate surplus along the southeastern coast of South Island and some areas of moderate deficit on North Island. Extreme deficits are forecast for New Caledonia.

The 3-month maps (below) show the evolving conditions in greater detail.

ISciences Water Anomalies Forecast
Australia & New Zealand: June 2019 - May 2020



Based on observed data through August 2019 and forecasts through May 2020

The forecast through November indicates deficits ranging from severe to exceptional in a vast stretch of eastern Australia from Rockhampton in Queensland (QLD) reaching south to Melbourne. Deficits will be exceptional in the Darling Downs, QLD; extreme near Brisbane and Canberra; and severe to exceptional in the eastern Murray-Darling Basin. Deficits will shrink and downgrade somewhat in Tasmania but will be severe. In the southwestern tip of Western Australia (WA) deficits will also shrink but will remain exceptional along the Blackwood River. Exceptional deficits are forecast for the eastern portion of the Great Sandy Desert in Western Australia and moderate to exceptional deficits in the center of the state. Moderate deficits will persist in Top End, Northern Territory (NT); southern South Australia; and the western Murray-Darling Basin.

Nearly normal water conditions are expected in New Zealand with some pockets of moderate surplus. Severe to extreme deficits will persist in New Caledonia.

From December 2019 through February 2020, conditions will normalize in much of Australia and New Zealand. Moderate deficits are forecast from eastern New South Wales through southeastern Victoria, including Sydney, Canberra, and Melbourne. Deficits will shrink and moderate in Tasmania and New Caledonia. Some moderate surpluses will re-emerge in the northern Simpson Desert along the southern border of NT and QLD, and surpluses will increase along a path near the coast in south-central WA northwest of Esperance.

The forecast for the final months – March through May 2020 – indicates mild deficits or normal conditions overall in the region.

(It should be noted that forecast skill declines with longer lead times.)