# Section 12

## Thematic Reviews

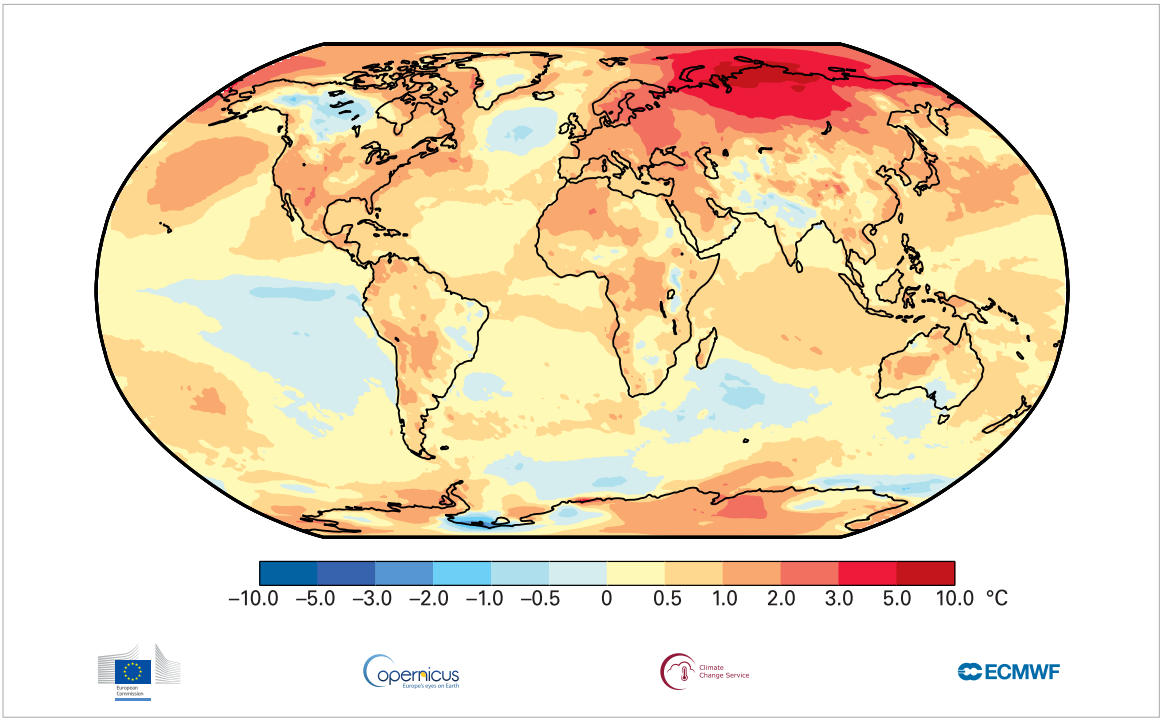
# 12.1. Climate Change

Extreme weather combined with COVID-19 in a double blow for millions of people in 2020. However, the pandemic-related economic slowdown failed to put a brake on climate change drivers and accelerating impacts, according to a new report compiled by WMO and an extensive network of partners.

# State of the Climate Indicators in 2020

**Temperature.** 2020 was one of the three warmest years on record, despite a cooling La Niña event. The global average temperature was about 1.2°C above the pre-industrial (1850-1900) level. The six years since 2015 have been the warmest on record. 2011-2020 was the warmest decade on record.

Temperature anomalies relative to the 1981-2010 long-term average from the ERA5 reanalysis for 2020




*Source:* Copernicus Climate Change Service, European Centre for Medium-Range Weather Forecasts (ECMWF)

**Greenhouse gases.** Concentrations of the major greenhouse gases continued to increase in 2019 and 2020. Globally averaged mole fractions of carbon dioxide ($CO_2$) have already exceeded 410 parts per million (ppm), and if the $CO_2$ concentration follows the same pattern as in previous years, it could reach or exceed 414 ppm in 2021, according to the report. The economic slowdown temporarily depressed new greenhouse gas emissions, according to UNEP, but had no discernible impact on atmospheric concentrations.

**Oceans.** The ocean absorbs around 23% of the annual emissions of anthropogenic $CO_2$ into the atmosphere and acts as a buffer against climate change. The ocean also absorbs more than 90% of the excess heat from human activities. 2019 saw the highest ocean heat content on record, and this trend likely continued in 2020. Over 80% of the ocean area experienced at least one marine heatwave in 2020. The percentage of the ocean that experienced "strong" marine heat waves (45%) was greater than that which experienced "moderate" marine heat waves (28%).

**Cryosphere.** The 2020 Arctic sea-ice extent minimum after the summer melt was 3.74 million $km^2$, marking only the second time on record that it shrank to less than 4 million $km^2$. Record low sea-ice extents were observed in the months of July and October. Record high temperatures north of the Arctic Circle in Siberia triggered an acceleration of sea-ice melt in the East Siberian and Laptev Seas, which saw a prolonged marine heatwave. The Antarctic sea-ice extent remained close to the long-term average.

The Antarctic ice sheet has exhibited a strong mass loss trend since the late 1990s. This trend accelerated around 2005, and currently, Antarctica loses approximately 175 to 225 Gt per year, due to the increasing flow rates of major glaciers in West Antarctica and the Antarctic Peninsula. A loss of 200 Gt of ice per year corresponds to about twice the annual discharge of the river Rhine in Europe.

**Floods and droughts.** Heavy rain and extensive flooding occurred over large parts of Africa and Asia in 2020. Heavy rain and flooding affected much of the Sahel and the Greater Horn of Africa, triggering a desert locust outbreak.

The Indian subcontinent and neighboring areas, China, the Republic of Korea and Japan, and parts of South-East Asia also received abnormally high rainfall at various times of the year.

Severe drought affected many parts of the interior of South America in 2020, with the worst-affected areas being northern Argentina, Paraguay and the western border areas of Brazil. The estimated agricultural losses were near US $3 billion in Brazil, with addi-

tional losses in Argentina, Uruguay and Paraguay. Long-term drought continued to persist in parts of southern Africa, particularly the Northern and Eastern Cape Provinces of South Africa.

**Heat and fire.** In a large region of the Siberian Arctic, temperatures in 2020 were more than 3°C above average, with a record temperature of 38°C in the town of Verkhoyansk. This was accompanied by prolonged and widespread wildfires.

In the USA, the largest fires ever recorded occurred in late summer and autumn. Widespread drought contributed to the fires, and July to September were the hottest and driest on record for the southwest. Death Valley in California reached 54.4°C on 16 August, the highest known temperature in the world in at least the last 80 years.

In the Caribbean, major heatwaves occurred in April and September. Cuba saw a new national temperature record of 39.7°C on 12 April. Further extreme heat in September saw national or territorial records set for Dominica, Grenada and Puerto Rico.

Australia broke heat records in early 2020, including the highest observed temperature in an Australian metropolitan area, in western Sydney, when Penrith reached 48.9°C.

The summer was very hot in parts of East Asia. Hamamatsu (41.1°C) equaled Japan's national record on 17 August.

Europe experienced drought and heatwaves during summer 2020, although these were generally not as intense as in 2018 and 2019. In the eastern Mediterranean with all-time records set in Jerusalem (42.7°C) and Eilat (48.9°C) on 4 September, following a late July heatwave in the Middle East in which Kuwait Airport reached 52.1°C and Baghdad 51.8°C.

**Tropical Cyclones.** With 30 named storms, the 2020 North Atlantic hurricane season had its largest number of named storms on record. There were a record 12 landfalls in the United States of America, breaking the previous record of nine. *Hurricane Laura* reached category 4 intensity and made landfall on 27 August in western Louisiana, leading to extensive damage and US$ 19 billion in economic losses. Laura was also associated with extensive flood damage in Haiti and the Dominican Republic in its developing phase. The last storm of the season, *Iota*, was also the most intense, reaching category 5 before landfall in Central America. *Cyclone Amphan*, which made landfall on 20 May near the India-Bangladesh border, was the costliest tropical cyclone on record for the North Indian Ocean, with reported economic losses in India of approximately US$14 billion. The strongest tropical cyclone of the season was *Typhoon Goni (Rolly)*. It crossed the northern Philippines with a 10-minute mean wind speed of 220 km/h (or higher) at its initial landfall, making it one of the most intense landfalls on record (1 November). Tropical *Cyclone Harold* had significant impacts in the northern islands of Vanuatu on 6 April, affecting about 65% of the population and also resulting in damage in Fiji, Tonga and the Solomon Islands. *Storm Alex* in early October brought extreme winds to western France, whilst heavy rain extended across a wide area. Other major severe storms included a hailstorm in Calgary (Canada) on 13 June, with insured losses exceeding US $1 billion and a hailstorm in Tripoli (Libya) on 27 October, with hailstones as large as 20 cm, accompanied by unusually cold conditions.

### Lessons and opportunities for enhancing climate action

According to the International Monetary Fund, while the current global recession caused by the COVID-19 pandemic may make it challenging to enact the policies needed for mitigation, it also presents opportunities to set the economy on a greener path by boosting investment in green and resilient public infrastructure, thus supporting GDP and employment during the recovery phase.

Adaptation policies aimed at enhancing resilience to a changing climate, such as investing in disaster-proof infrastructure and early warning systems, risk sharing through financial markets, and the development of social safety nets, can limit the impact of weather-related shocks and help the economy recover faster.

*Source:* WMO, https://library.wmo.int/index.php?lvl=notice_display&id=21880#.YOsdsegzbIX

## Climate Change Agreement

On 12 December 2015, a historic climate agreement was signed in Paris, uniting all countries of the world in the desire to reduce greenhouse gas emissions, switch to clean energy sources and adapt to the effects of climate change. How did these 5 years go for the post-Soviet countries? "The approved commitments and plans of no country in the EECCA region are considering reducing greenhouse gas emissions by 2030," says the new CAN EECCA report "Climate Policy Analysis of Eastern Europe, Caucasus and Central Asia". The report includes data for Azerbaijan, Georgia, Kyrgyzstan, Armenia, Belarus, Kazakhstan, Moldova, Tajikistan, Uzbekistan, Russia and Ukraine.

In the countries of Central Asia, when planning climate policy, considerable attention is paid to climate change adaptation. Problems begin at the implementation level, because in general adaptation projects are either not linked by one systematic approach, or are very vague, without an action plan.

This year Kyrgyzstan and Tajikistan have officially announced the revision of their contributions to the Paris Agreement. Moldova made its second contribution to the UNFCCC in March, and Ukraine and Georgia will soon approve the updated NDCs. So far, these contributions either do not imply a reduction in green-

house gas emissions, or provide a very small percentage of reduction, which does not contribute to the implementation of the Paris Agreement goals.

*Report is available on* https://infoclimate.org/eng/analysis-of-climate-policies-of-the-countries-of-eastern-europe-caucasus-and-central-asia/

**The 26th Conference of the Parties (COP26) to UNFCCC.** The COP26 UN Climate Change Conference, hosted by the UK in partnership with Italy, will take place from 31 October to 12 November 2021 in the Scottish Event Campus (SEC) in Glasgow, UK. In light of the worldwide effects of COVID-19, the Conference was rescheduled initially slated for November 2020. Rescheduling the conference ensures that all parties can focus on the issues to be discussed at this vital conference and allows more time for the necessary preparations to take place.

## Reports on Climate Change

A new ICRC report[94], When Rain Turns to Dust, explores how countries enduring conflict are disproportionately affected by climate change and climate variability.

Here are seven things you need to know.

**1. Of the 25 countries deemed most vulnerable to climate change, 14 are mired in conflict**

The Notre Dame Global Adaptation Initiative Index looks at a country's vulnerability to climate change and other global challenges, set against its ability to improve resilience. Yemen, Mali, Afghanistan, Democratic Republic of the Congo and Somalia, all of which are dealing with conflict, are among the lowest ranked. This is not to say that there is a direct correlation between climate change and conflict. Rather, it suggests that countries enduring conflict are less able to cope with climate change, precisely because their ability to adapt is weakened by conflict.

People living in conflict zones are therefore among the most vulnerable to the climate crisis and most neglected by climate action.

**2. Climate change does not directly cause conflict, but...**

Scientists generally agree that climate change does not directly cause armed conflict, but that it may indirectly increase the risk of conflict by exacerbating existing social, economic and environmental factors. For example, when cattle herders and agricultural farmers are pushed to share diminishing resources due to a changing climate, this can stir tensions in places that lack strong governance and inclusive institutions.

**3. Insecurity limits people's ability to cope with climate shocks**

The following case study from Mali, which has seen years of conflict, illustrates this point. In early 2019, grazing land became scarce south of Gao, due to floods. Pastoralists were worried about travelling with their livestock for fear of being attacked by armed groups or bandits. Instead, they often gathered in areas close to water sources, creating tensions with farmers and fishermen. Insecurity prevented them from reaching livestock markets further afield, where they could have hoped for better prices. State officials – and potential state support – were absent because of the violence. Violence also considerably limited humanitarian access. In short, impoverished herders watched their only assets wither and were left struggling to feed their families.

**4. Adapting to climate change can be relatively simple, but it tends to be complicated**

In certain circumstances, a change in the crops being cultivated might be sufficient. But adapting to climate change may also require major social, cultural or economic changes. A whole agricultural system might need to change, or diseases new to a geographical area might need to be dealt with. Concerted efforts to adapt tend to be limited in times of war. In a conflict situation, authorities and institutions are not only weak, but also preoccupied with security priorities.

**5. The natural environment is frequently a casualty of conflict**

Too often, the natural environment is directly attacked or damaged by warfare. Attacks can lead to water, soil and land contamination, or release pollutants into the air. Explosive remnants of war can contaminate soil and water sources, and harm wildlife. Such environmental degradation reduces people's resilience and ability to adapt to climate change.

The indirect effects of conflict can also result in further environmental degradation, for example: authorities are less able to manage and protect the environment; large-scale displacement places strain on resources; natural resources can be exploited to sustain war economies. In Fao, south of Basra, Iraq, people blame their water and farming problems on the felling of date palms for military purposes during the Iran-Iraq war.

Conflict can also contribute to climate change. For example, the destruction of large areas of forest, or damage to infrastructure such as oil installations or big industrial facilities, can have detrimental climate consequences, including the release of large volumes of greenhouse gases into the air.

[94] International Committee of the Red Cross

**6. International humanitarian law (IHL) provides protection to the natural environment**

As early as 1977, states afforded the natural environment protection against widespread, long-term and severe damage through Additional Protocol I to the Geneva Conventions.

Greater respect for the rules of war can reduce the harm and risks that conflict-affected communities are exposed to as a result of climate change.

For example, climate change can drive water scarcity and reduce the availability of arable land. By prohibiting attacks on objects indispensable to the survival of the civilian population, such as agricultural areas and drinking water, IHL protects these resources from additional conflict-related violence.

**7. Humanitarian action must adapt**

The climate crisis is altering the nature and severity of humanitarian crises. Humanitarian organizations are already struggling to respond and will not be able to meet exponentially growing needs resulting from unmitigated climate change.

Major efforts – in the form of significant systemic and structural changes, political will, good governance, investment, technical knowledge, a shift in mindsets – are needed to limit climate change.

Humanitarian organizations must collaborate to strengthen climate action. While people in conflict zones are among the most vulnerable to climate change, there is a gap in funding for climate action between stable and fragile countries. A greater share of climate finance needs to be allocated to places affected by conflict to help communities adapt to climate change.

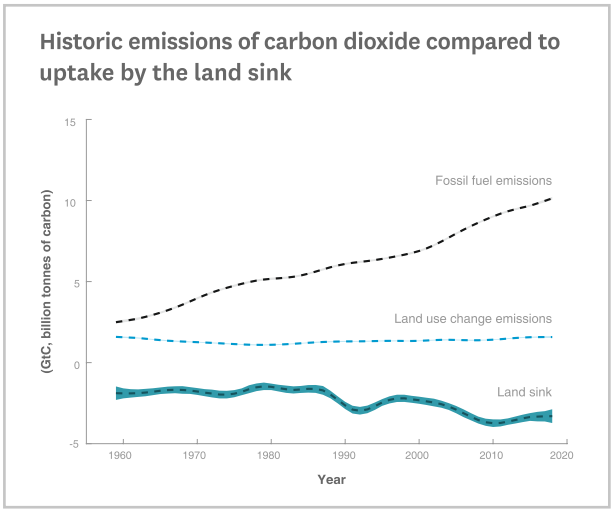
*Source:*
https://www.icrc.org/sites/default/files/topic/file_plus_list/rain_turns_to_dust_climate_change_conflict.pdf

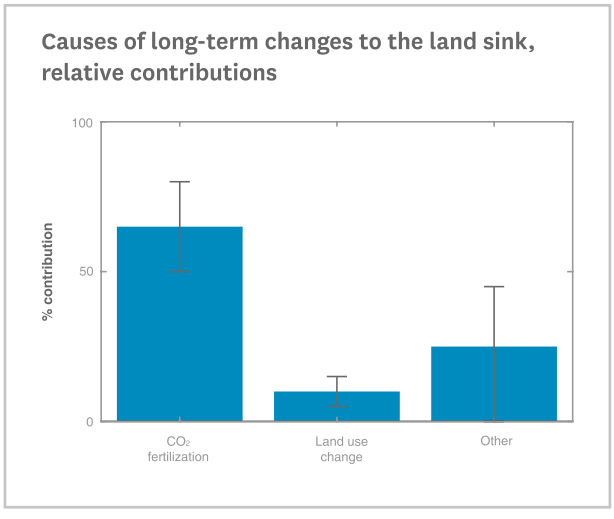
**The 10 New Insights in Climate Science 2020** (full report) intends to take up the latest and most essential scientific findings in climatology.

**1. Improved models strengthen support for ambitious emission cuts to meet Paris Agreement:** (1) Earth's temperature response to doubling the levels of carbon dioxide in the atmosphere is now better understood. While previous IPCC assessments have used an estimated range of 1.5-4.5°C, recent research now suggests a narrower range of 2.3-4.5°C; (2) This means that moderate emissions reduction scenarios are less likely to meet the Paris temperature targets than previously anticipated; (3) Improved regional scale models provide better information about heavy rainfall events and hot and cold extremes, offering new opportunities for water resource management; (4) Regional climate predictions can now be made up to a decade ahead with higher skill than previously thought possible.

**2. Emissions from thawing permafrost likely to be worse than expected:** (1) Emissions of greenhouse gases from permafrost will be larger than earlier projections because of abrupt thaw processes, which are not yet included in global climate models; (2) These abrupt thaw effects could as much as double the emissions from permafrost thaw under moderate and high emissions scenarios; (3) Emissions from permafrost thaw could be yet higher due to effects on plant root activity, which increases soil respiration.

**3. Deforestation is degrading the tropical carbon sink:** (1) Land ecosystems currently draw down 30% of human $CO_2$ emissions due to a $CO_2$ fertilization effect on plants; (2) Deforestation of the world's tropical forests are causing these to level off as a carbon sink but this is balanced by greater recent carbon uptake in the Northern Hemisphere; (3) Global plant biomass uptake of carbon due to $CO_2$ fertilization may be limited in the future by nitrogen and phosphorus; (4) $CO_2$ emissions from land-use changes continue to be high in the 21st century and remain a large threat to the land sink.



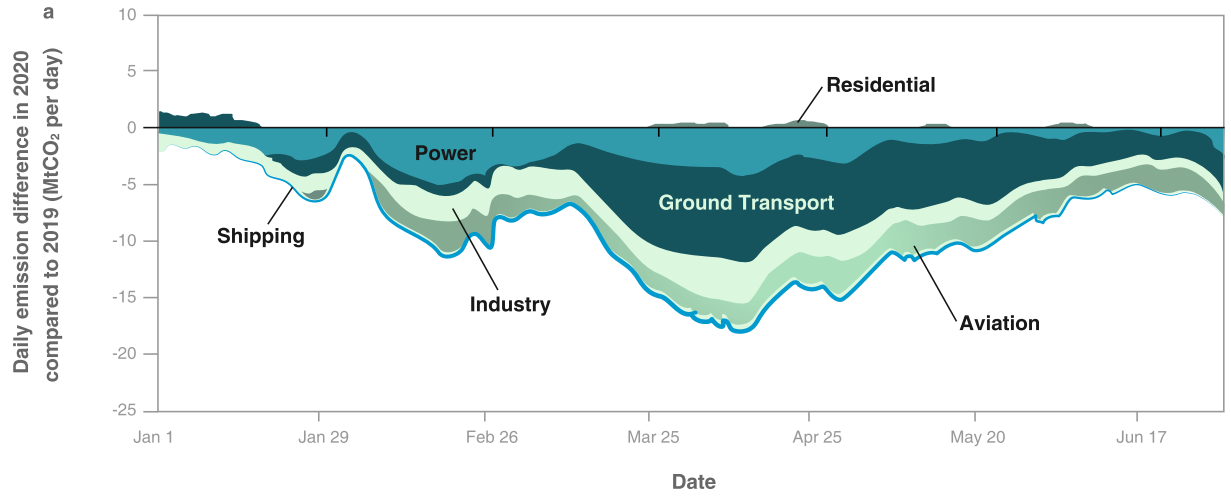

**4. Climate change will severely exacerbate the water crisis:** (1) Crises of water quality and quantity are intimately linked with climate change and increasing extremes; (2) New empirical studies show that climate change is already causing extreme precipitation events (floods and droughts), and these extreme set-

tings in turn lead to water crises; (3) The impact of these water crises is highly unequal, which is caused by and exacerbates gender, income, and sociopolitical inequality; (4) Climate change coupled with socioeconomic drivers can impact access to water of good quality; (5) Water-related climate extreme events are contributing to the migration and displacement of millions of people; migration is being treated as an adaptation strategy within the international policy community.

**5. Climate change can profoundly affect our mental health:** (1) Climate change can directly and indirectly adversely affect mental health over short and longer time scales. Growing evidence suggests the overall burden of mental health impacts of climate variability is high and will increase with additional climate change; (2) Cascading and compounding risks are contributing to anxiety and distress; (3) The mental health consequences of climate variability and change can affect anyone but disproportionately affects those suffering from health inequities; (4) The promotion and conservation of blue and green spaces within urban planning policies as well as the protection of ecosystems and biodiversity in natural environments have health co-benefits and provide resilience.

**6. Governments are not yet seizing the opportunity for a green recovery from COVID-19:** (1)Temporary COVID-19 lockdowns resulted in a large and unprecedented global reduction in GHG emissions and visible improvements in urban air quality; (2) The substantial drops in GHG emissions during COVID-19-induced lockdowns are unlikely to have any significant long-term impact on global emission trajectories; (3) Governments all over the world have committed to mobilizing more than US $12 trillion for COVID-19 pandemic recovery. As a comparison, annual investments needed for a Paris-compatible emissions pathway are estimated to be US $1.4 trillion; (4) Stimulus packages allocated by leading economies for agriculture, industry, waste, energy, and transport, amounting to US $3.7 trillion, have the potential to reduce emissions from these sectors significantly but governments do not seem to be seizing this opportunity; (5) Governments' economic stimulus packages will shape GHG emissions trajectories for decades to come – for better or worse. If invested in climate-compatible activities, they could be a turning point for climate protection.

Effect of restrictions to control COVID-19 on global $CO_2$ emissions in 2020, per sector. Adapted from Liu and coauthors, 2020




**7. COVID-19 and climate change demonstrate the need for a new social contract:** (1) COVID-19 and climate change exemplify transboundary risks that erode human well-being and economic security, particularly affecting the most vulnerable; (2) The pandemic has spotlighted inadequacies of both governments and international institutions to cope with transboundary risks; (3) Accelerating climate risks require innovative approaches to governance; (4) Some communities and governments have demonstrated that COVID-19 risks can be addressed with innovative local, national, and international responses, and stronger global responses are needed; (5) NGOs, community groups, youth movements, and many other social actors have shown that transboundary responses to global risks of climate change are also possible and there is mounting pressure on governments to act decisively. A new social compact would strengthen the prospects for a humane and just world with a stable climate.

**8. Economic stimulus focused primarily on growth would jeopardize the Paris Agreement:** (1) A growing number of studies highlight the economic benefits of strategies that stay well below 2°C or even 1.5°C; (2) The costs of renewable energy, battery-electric vehicles, and other low-carbon solutions have fallen dramatically; (3) A COVID-19 recovery strategy based on growth first and sustainability second is likely to fail the Paris Agreement; (4) Investments are needed for a system transition but all must contribute to net energy or $CO_2$ savings in line with the Paris Agreement.

**9. Electrification in cities is pivotal for just sustainability transitions:** (1) Urban electrification is a powerful pathway to an equitable energy transition; (2) Over a billion people who currently lack access to electricity will benefit from stronger electrification efforts; (3) Reductions in local air pollution and improvements to health and quality of life are tangible co-benefits of urban electrification; (4) An actor-oriented, equity-based approach to the transition will maximize the benefits and mitigate the risks of urban electrification, such as generating a new electrical divide.

**10. Going to court to defend human rights can be an essential climate action:** (1) Rights-based litigation is emerging as a tool to address climate change; (2) Through such climate litigation, legal understandings of who or what is a rightsholder are expanding to include future, unborn generations, and elements of nature, as well as who can represent them in court; (3) Climate litigation shows cross-fertilization between outcomes in different courts and tribunals, such as national case law influencing responses of international tribunals; (4) Climate-related court cases address harm to people also across national boundaries; (5) Courts come in as "lawmakers" to address climate change, given the absence of adequate climate action in other contexts.

*Source:* https://10nics2020.futureearth.org/

**State and Trends in Adaptation Report.** On 18 December, the Global Center on Adaptation presented its report "Building Forward Better from Covid-19: Accelerating Action on Climate Adaptation", the first in a series that will assess progress on climate adaptation and provide guidance and recommendations on best practice in adapting to the effects of a changing climate and building resilience to climate shocks. The report highlights the many successful adaptation initiatives with the potential to be scaled up and replicated. It also flags key policy, skills and finance gaps that must be addressed if adaptation is to be effective and reach those who need it the most.

Climate-change impacts continue to grow in magnitude and frequency. Yet recent progress on adaptation has slowed because of the COVID-19 pandemic. The following policy recommendations are designed not only to accelerate adaptation and resilience action, but to help the world win back the momentum lost due to COVID. The recommendations are aimed at strengthening:

**1. Understanding:** To ensure that the risks are fully understood and reflected in the decisions that public and private actors make;

**2. Planning:** To improve policy and investment decisions and how we implement solutions;

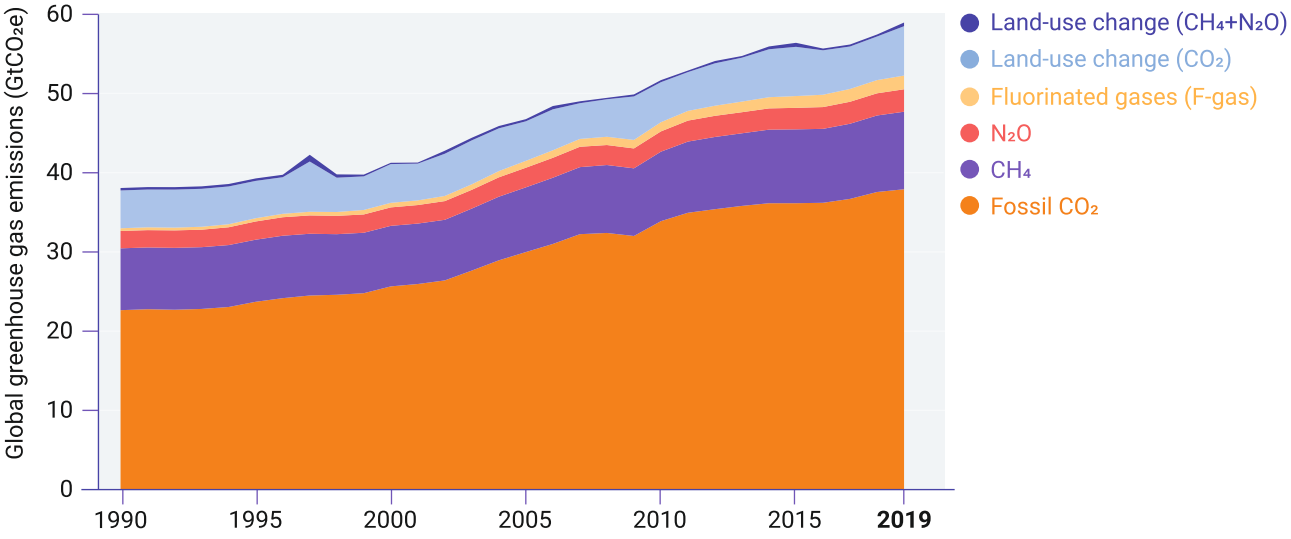
**3. Finance:** To mobilize the funds and resources necessary to accelerate adaptation.

*The Report is available on* https://gca.org/wp-content/uploads/2021/03/GCA-State-and-Trends-Report-2020-Online-3.pdf

**UNEP issued the 11th edition of the UN Environment Emissions Gap Report** (1 December). It assesses the latest scientific studies on current and estimated future GHG emissions and compares these with the emission levels permissible for the world to progress on a least-cost pathway to achieve the goals of the Paris Agreement. It includes the following key conclusions:

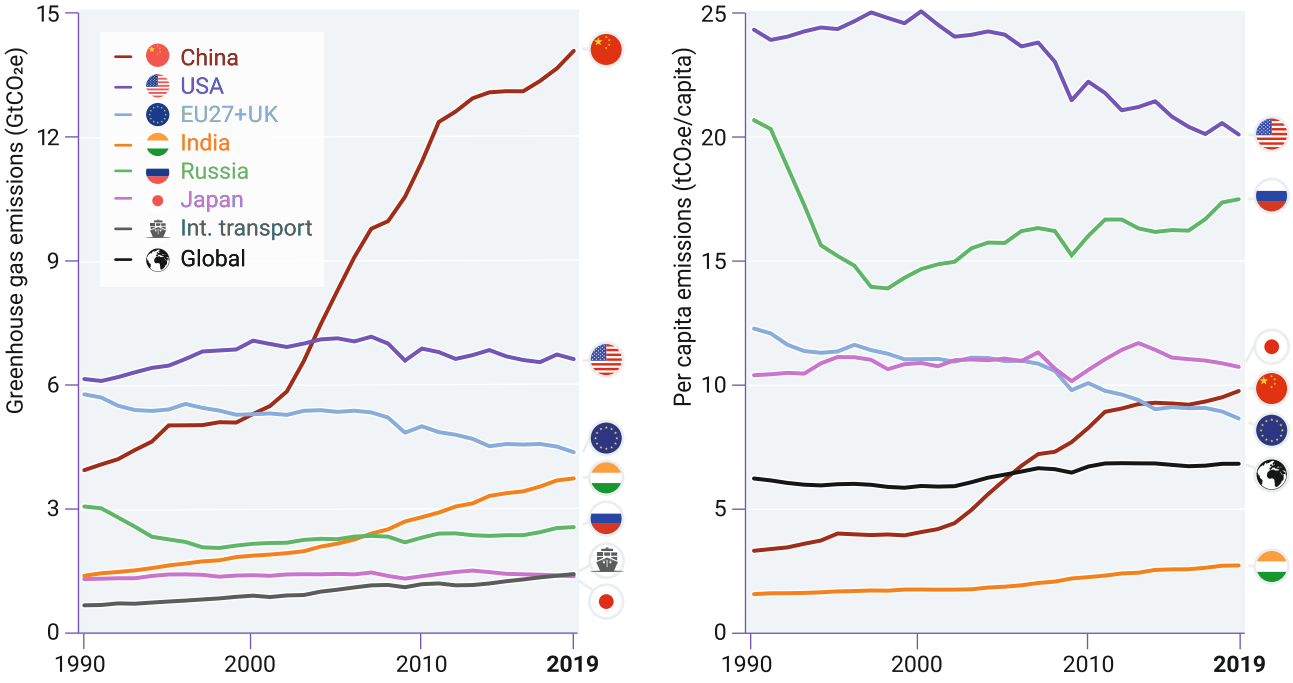
1. Global GHG emissions continued to grow for the third consecutive year in 2019, reaching a record high of 52.4 $GtCO_2e$ (range: ±5.2) without land-use change (LUC) emissions and 59.1 $GtCO_2e$ (range: ±5.9) when including LUC.

Global GHG emissions from all sources



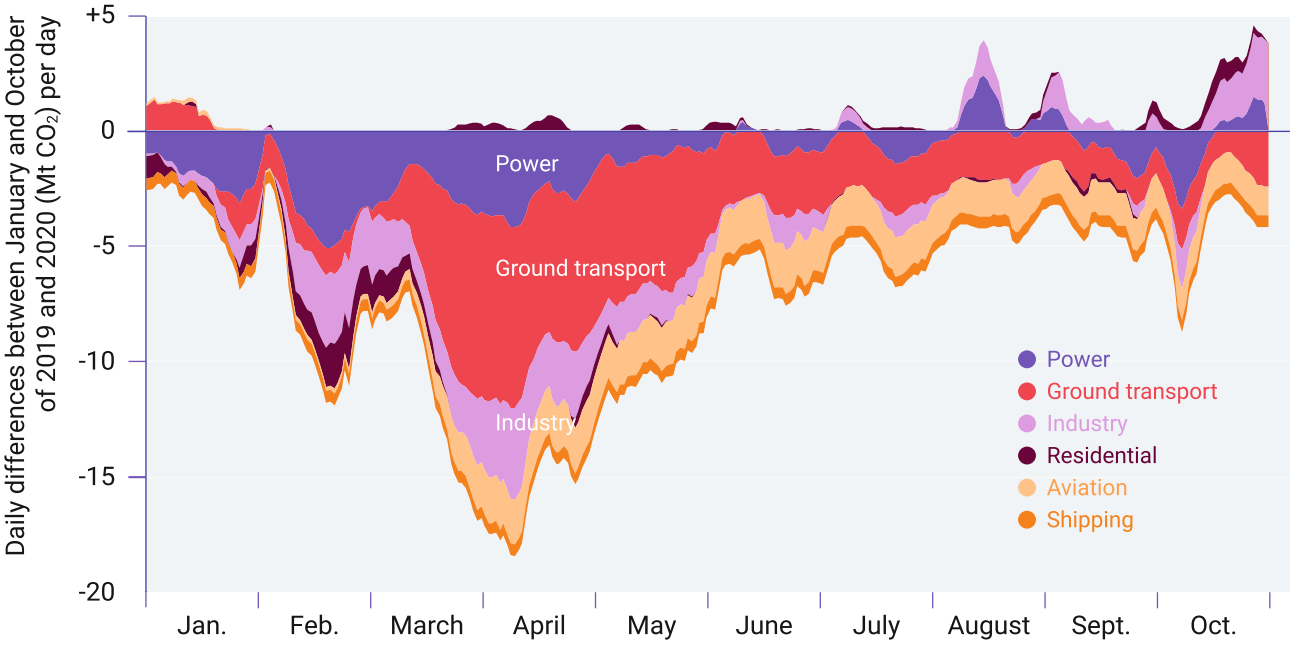

2. $CO_2$ emissions could decrease by about 7% in 2020 (range: 2-12%) compared with 2019 emission levels due to COVID-19, with a smaller drop expected in GHG emissions as non-$CO_2$ is likely to be less affected. However, atmospheric concentrations of GHGs continue to rise.

Absolute GHG emissions of the top six emitters (excluding LUC emissions) and international transport (left) and per capita emissions of the top six emitters and the global average (right)




3. The COVID-19 crisis offers only a short-term reduction in global emissions and will not contribute significantly to emissions reductions by 2030 unless countries pursue an economic recovery that incorporates strong decarbonization.

Reduction in emissions in 2020 relative to 2019 levels due to COVID-19 lockdowns




4. The growing number of countries that are committing to net-zero emissions goals by around mid-century is the most significant and encouraging climate policy development of 2020. To remain feasible and credible, it is imperative that these commitments are urgently translated into strong near-term policies and action, and are reflected in the NDCs.

5. Collectively, G20 members are projected to overachieve their modest 2020 Cancun Pledges, but they are not on track to achieve their NDC commitments. Nine G20 members are on track to achieve their 2030 NDC commitments, five members are not on track, and for two members there is a lack of sufficient information to determine this.

6. The emissions gap has not been narrowed compared with 2019 and is, as yet, unaffected by COVID-19. By 2030, annual emissions need to be 15 $GtCO_2e$ (ran-

ge: 12-19 $GtCO_2e$) lower than current unconditional NDCs imply for a 2°C goal, and 32 $GtCO_2e$ (range: 29-36 $GtCO_2e$) lower for the 1.5°C goal. Collectively, current policies fall short 3 $GtCO_2e$ of meeting the level associated with full implementation of the unconditional NDCs.

7. Current NDCs remain seriously inadequate to achieve the climate goals of the Paris Agreement and would lead to a temperature increase of at least 3°C by the end of the century. Recently announced net-zero emissions goals could reduce this by about 0.5°C, provided that short-term NDCs and corresponding policies are made consistent with the net-zero goals.

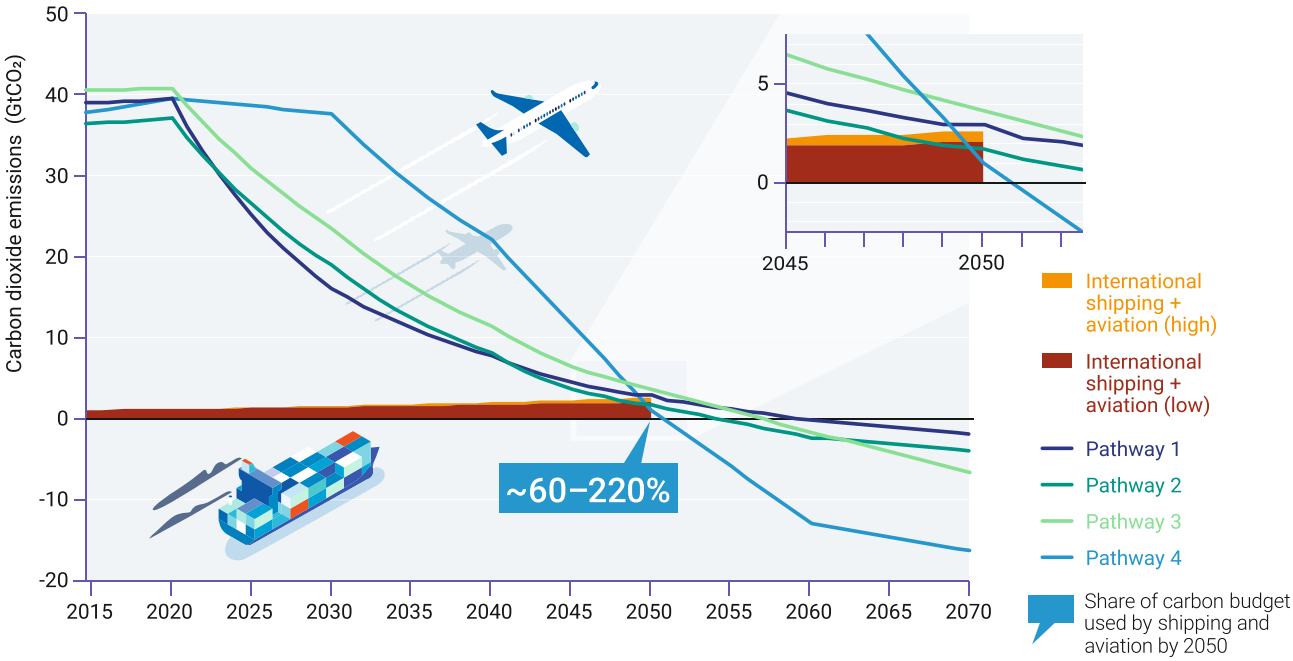
8. COVID-19-related fiscal spending by governments is of unprecedented scale, currently amounting to roughly US $12 trillion globally, or 12% of global GDP in 2020. For G20 members, fiscal spending amounts to around 15% of GDP on average for 2020.

9. So far, the opening for using fiscal rescue and recovery measures to stimulate the economy while simultaneously accelerating a low-carbon transition has largely been missed. It is not too late to seize future opportunities, without which achieving the Paris Agreement goals is likely to slip further out of reach.

10. Early COVID-19 fiscal rescue and recovery measures provide valuable insight for policymakers designing measures for the immediate future.

11. Domestic and international shipping and aviation currently account for around 5% of global $CO_2$ emissions and are projected to increase significantly. International emissions from shipping and aviation are not covered under the NDCs and, based on current trends, are projected to consume between 60 and 220% of allowable $CO_2$ emissions by 2050 under IPCC illustrative 1.5°C scenarios.

## Global $CO_2$ emissions pathways limiting global warming to 1.5°C and $CO_2$ emissions from international shipping and aviation




12. Current policy frameworks to address emissions are weak and additional policies are required to bridge the gap between the current trajectories of shipping and aviation and GHG emissions pathways consistent with the Paris Agreement temperature goals. Changes in technology, operations, fuel use and demand all need to be driven by new policies.

13. Lifestyle changes are a prerequisite for sustaining reductions in GHG emissions and for bridging the emissions gap. Around two thirds of global emissions are linked to the private household activities according to consumption-based accounting. Reducing emissions through lifestyle changes requires changing both broader systemic conditions and individual actions.

14. Equity is central to addressing lifestyles. The emissions of the richest 1% of the global population account for more than twice the combined share of the poorest 50%.

*The Report is available on*
https://www.unep.org/emissions-gap-report-2020

The **4th Yearbook of Global Climate Action** 2020 was issued. It presents the current range and state of global climate action by non-Party stakeholders (cities, regions, businesses, investors, and civil society), examines the impacts of the COVID-19 pandemic and opportunities for a green resilient recovery. It also explores the key elements of the Climate Action Pathways, and delivers key messages and reflections from the Champions on the future of the Marrakech Partnership for Global Climate Action.

*The Report is available on*
https://unfccc.int/sites/default/files/resource/2020_Yearbook_final_0.pdf

## Major and Significant Events

**UNSC** organized an Arria formula meeting on the theme of "Climate and security risks: the latest data. What can the United Nations do to prevent climate-related conflicts and how can we climate-proof United Nations in-country activities?" (22 April) and a ministerial-level open debate on "Climate and Security" in an open videoconference (24 July) (see Security Council).

**In December**, UN held a virtual Climate Ambition Summit 2020. Some 70 Heads of State, along with regional and city leaders, and heads of major businesses, have delivered a raft of new measures, policies and plans, aimed at making a big dent in greenhouse gas emissions, and ensuring that the warming of the planet is limited to 1.5°C. The UK announced that it would cut emissions by 68%, compared to 1990 levels, within the next five years, and the European Union bloc committed to a 55% cut over the same time. At least 24 countries announced new commitments, strategies or plans to reach carbon neutrality, and a number of states set out how they are going even further, with ambitious dates to reach net zero: Finland by 2035, Austria by 2040 and Sweden by 2045. Pakistan announced that its scrapping plans for new coal power plants, India will soon more than double its renewable energy target, and China committed to increasing the share of non-fossil fuel in primary energy consumption to around 25% by 2030.

**Global trends in climate change litigation in 2020.** At the end of May 2020, the Climate Change Laws of the World database featured 374 court cases in 36 countries (excluding the US) and 8 regional or international jurisdictions, as well as 1,872 climate laws and policies in 198 jurisdictions. The Sabin Center's database for the United States featured 1,213 climate lawsuits in the US up to the end of May 2020.

**The UNEP Global Climate Litigation Report: 2020 Status Review** provides an overview of the current state of climate change litigation globally, as well as an assessment of global climate change litigation trends. It finds that a rapid increase in climate litigation has occurred around the world. In 2017, 884 cases were brought in 24 countries; as of 2020, cases had nearly doubled, with at least 1,550 climate change cases filed in 38 countries (39 including the European Union courts). While climate litigation continues to be concentrated in high-income countries, the report's authors expect the trend to further grow in the global south – the report lists recent cases from Colombia, India, Pakistan, Peru, the Philippines and South Africa.

*The Report is available on*
https://wedocs.unep.org/bitstream/handle/20.500.11822/34818/GCLR.pdf?sequence=1&isAllowed=y

### Country Review

**European Court of Human Rights.** The European Court of Human Rights has told the governments of 33 industrialized countries to promptly respond to a climate lawsuit lodged by six youth campaigners in September. The plaintiffs range from age 8 to 21 and come from Lisbon and Leiria in Portugal. The case states climate change poses a rising threat to the six young people's lives and their physical and mental well-being. It invokes human rights arguments – including the right to life, a home and to family – as well as claiming discrimination.

**France.** France's top administrative court gave the government a three-month deadline to show it is taking action to meet its commitments on reducing greenhouse gas emissions.

**Republic of Ireland.** In July, Friends of the Irish Environment won a landmark case against the Irish government for failing to take sufficient action to address the climate and ecological crisis. The Supreme Court of Ireland ruled that the Irish government's 2017 National Mitigation Plan was inadequate, specifying that it did not provide enough detail on how it would reduce greenhouse gas emissions.

**United Kingdom.** In December, three British citizens, Marina Tricks, Adetola Onamade, Jerry Amokwandoh, and the climate litigation charity, Plan B, announced that they were taking legal action against the UK government for failing to take sufficient action to address the climate and ecological crisis. The plaintiffs announced that they will allege that the government's ongoing funding of fossil fuels both in the UK and other countries constitute a violation of their rights to life and to family life, as well as violating the Paris Agreement and the UK Climate Change Act of 2008.

**USA.** As of February, the U.S. had the most pending cases with over 1,000 in the court system. In September 2020, the city of Charleston, South Carolina made history Wednesday when it became the first in the U.S. South to sue the fossil fuel industry for damages caused by the climate crisis. The city sued 24 oil and pipeline companies, including major players like ExxonMobil, Chevron, BP and Royal Dutch Shell. The lawsuit contends that the companies knew that their products were heating the global climate but denied the fact in public. It further seeks to charge them for the costs of protecting Charleston from increased flooding and extreme weather events.

**Juliana v. United States climate change lawsuit.** The first case of its kind, Juliana v. the United States continued in 2020. 21 American teenagers aged from 9 to 20 filed a lawsuit against the US Government. Their complaint asserts that, through the government's affirmative actions that cause climate change, it has

Number of cases identified by jurisdiction, 1986 to May 2020

| | | | | | |
|---|---|---|---|---|---|
| Argentina | 1 | Australia | 98 | Austria | 2 |
| Belgium | 1 | Brazil | 6 | Canada | 22 |
| Chile | 2 | Colombia | 2 | Czech Republic | 1 |
| Ecuador | 1 | Estonia | 1 | European Union | 57 |
| France | 11 | Germany | 6 | International Court of Justice | 1 |
| India | 9 | Indonesia | 1 | Inter-American Court and Commission on Human Rights | 3 |
| Ireland | 4 | Japan | 3 | Kenya | 1 |
| Luxemburg | 1 | Mexico | 1 | Netherlands | 2 |
| New Zealand | 18 | Nigeria | 1 | Norway | 1 |
| OECD | 6 | Pakistan | 4 | Peru | 1 |
| Philippines | 2 | Poland | 3 | South Korea | 1 |
| South Africa | 4 | Spain | 13 | Sweden | 1 |
| Switzerland | 2 | Uganda | 1 | Ukraine | 2 |
| UN Committee on the Rights of the Child | 1 | UN Human Rights Committee | 2 | UN Framework Convention on Climate Change | 10 |
| United Kingdom | 62 | UN Special Rapporteurs | 2 | United States | 1,213 |

*Source:* Setzer J and Byrnes R (2020) Global trends in climate change litigation: 2020 snapshot. London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, Sabin Center for Climate Change Law; https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2020/07/Global-trends-in-climate-change-litigation_2020-snapshot.pdf

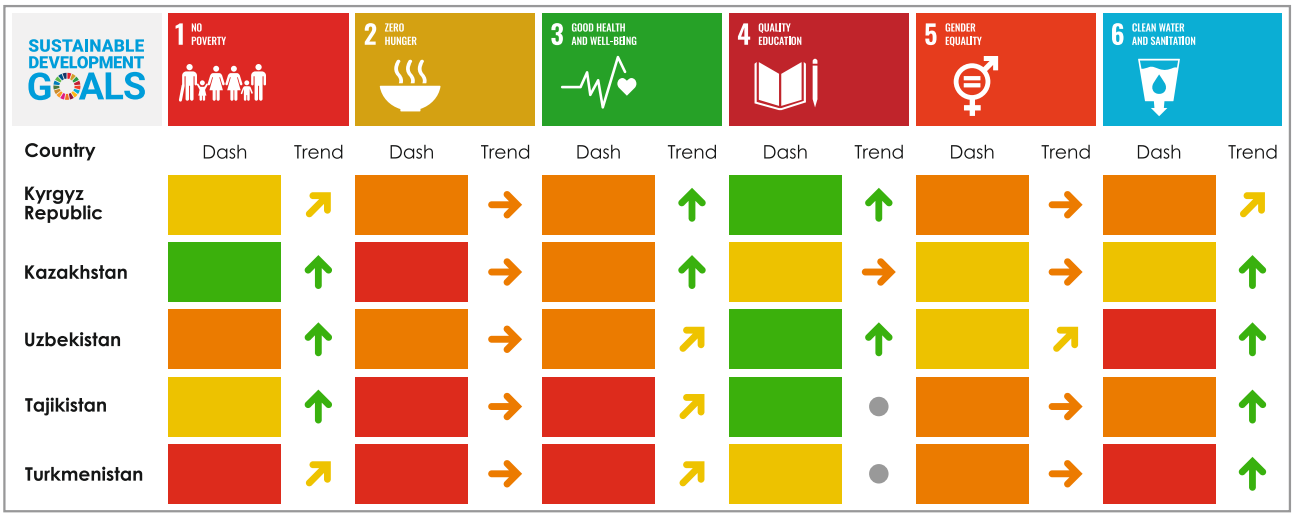
violated the youngest generation's constitutional rights to life, liberty, and property, as well as failed to protect essential public trust resource[95]. On **17 January 2020**, the Ninth Circuit reversed the lower court in the Juliana case, ruling that the plaintiffs do not have standing to pursue their claims because they cannot show that the court has the power to grant the specific remedy plaintiffs seek for the harms they have suffered. On **2 March 2020**, attorneys for the plaintiffs filed a petition for rehearing en banc with the Ninth Circuit Court of Appeals. This petition requests that the full Ninth Circuit Court of Appeals convene a new panel of 11 circuit court judges to review January's sharply divided opinion.

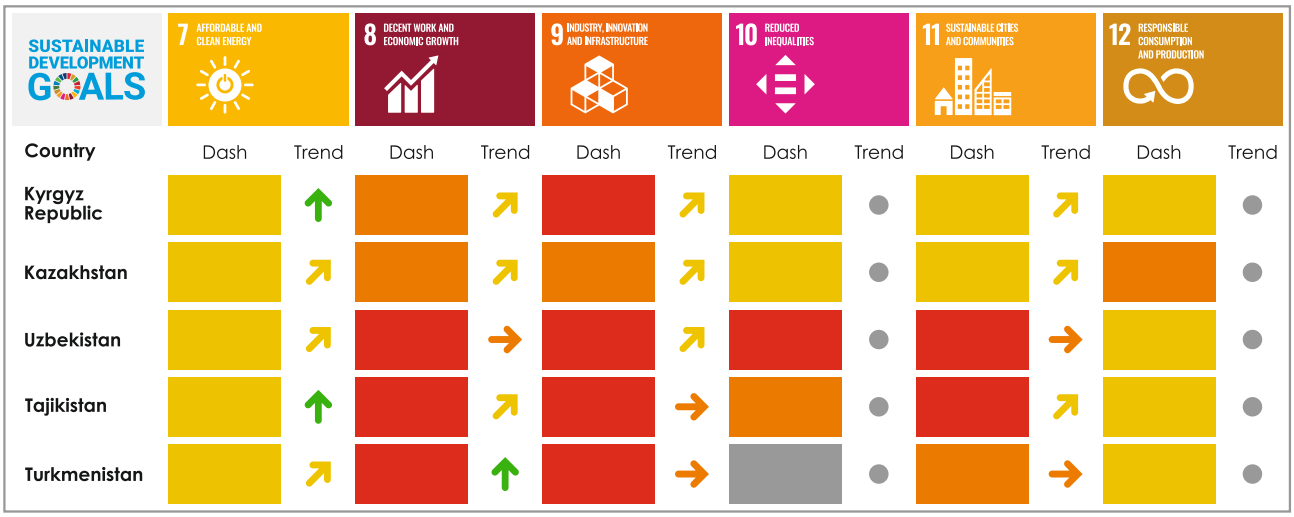
## 12.2. Sustainable Development Goals: Tracking the 2020 Progress in Central Asia

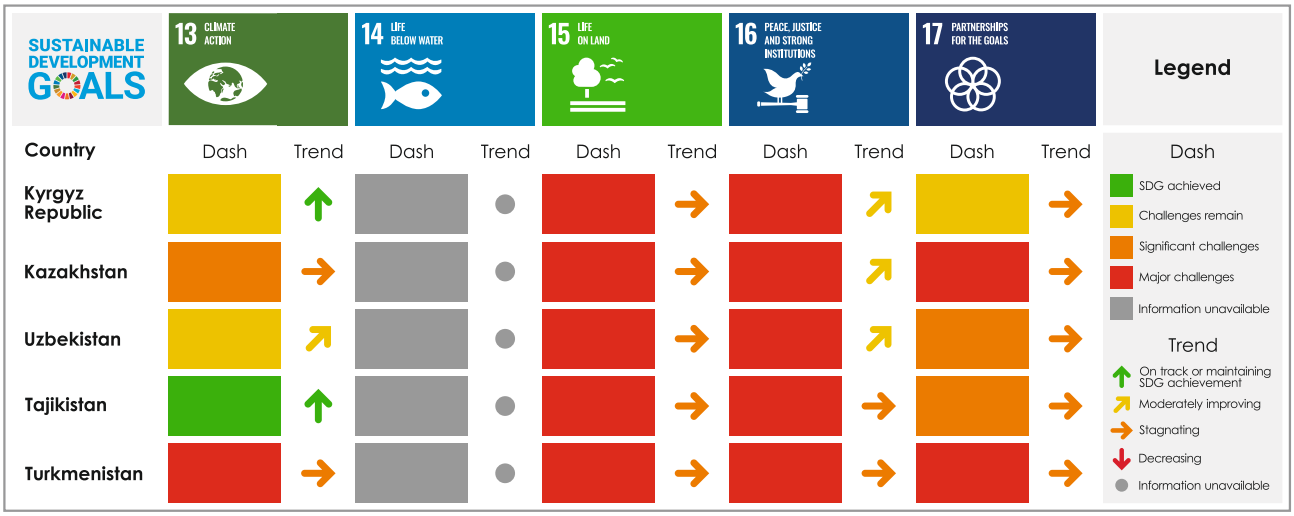
In this section we present an overview of progress towards the SDGs in Central Asian countries. Information is drawn from The Sustainable Development Goals Report 2020 – a global assessment of countries' progress towards achieving the SDGs. It is a complement to the official SDG indicators and the voluntary national reviews. The report presents a global overview of progress towards the SDGs before the pandemic started, but it also looks at some of the devastating initial impacts of COVID-19 on specific Goals and targets. The report was prepared by the UN Department of Economic and Social Affairs in collaboration with over 200 experts from more than 40 international agencies, using the latest available data and estimates.

[95] https://www.ourchildrenstrust.org/juliana-v-us

| Country | 2020 SDG Index Score | 2020 SDG Index Rank | Spillover Score (0-100) |
|---|---|---|---|
| Kyrgyz Republic | 73.01 | 52 | 96.05 |
| Kazakhstan | 71.06 | 65 | 93.99 |
| Uzbekistan | 71.02 | 66 | 98.08 |
| Tajikistan | 69.43 | 78 | 97.54 |
| Turkmenistan | 63.03 | 114 | 90.44 |



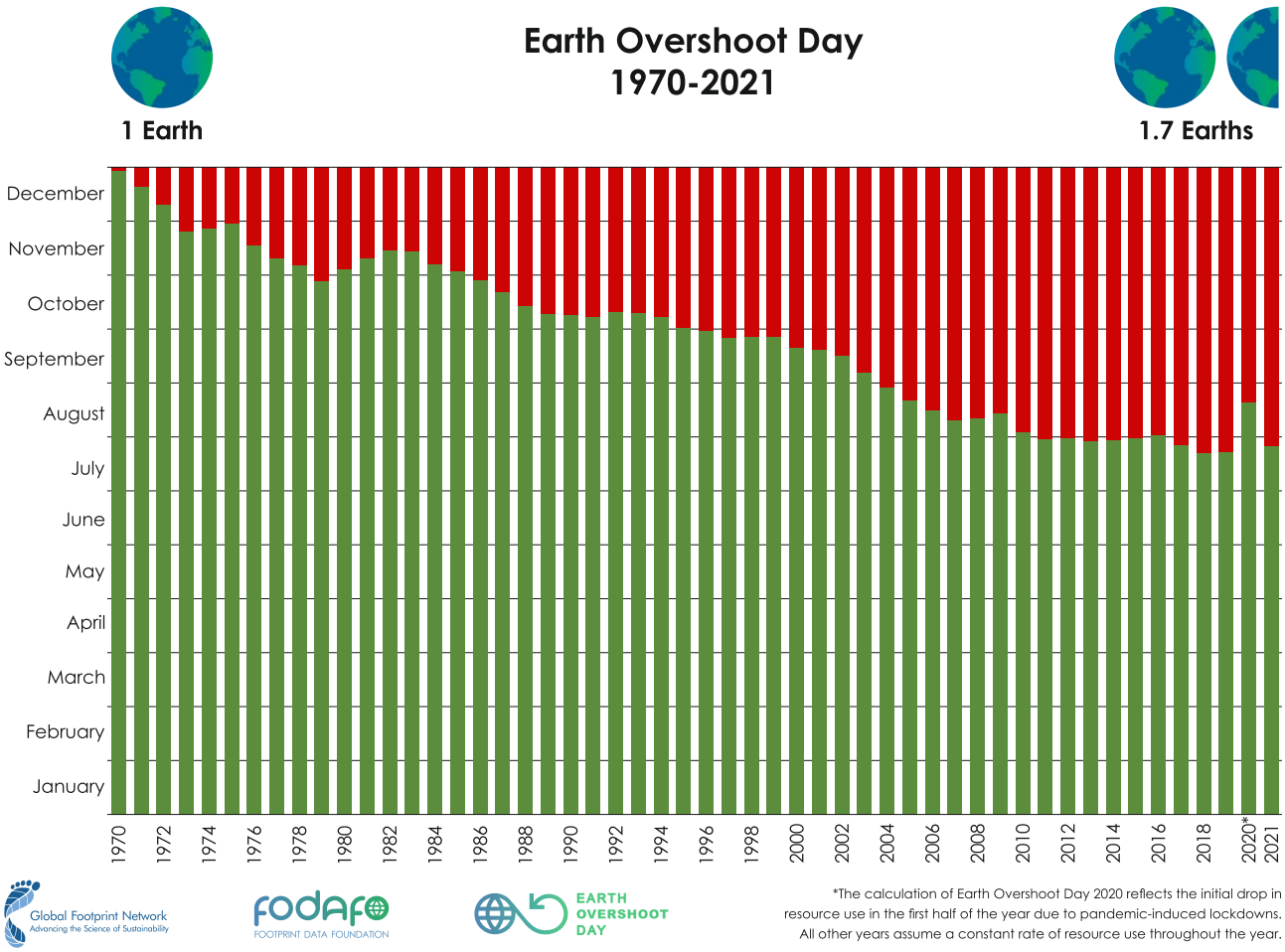



# 12.3. Earth Overshoot Day 2020

In 2020, the calculated Overshoot Day fell on August 22 (more than three weeks later than 2019) due to coronavirus induced lockdowns around the world. Earth Overshoot Day marks the date when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year. The earlier the eco-debt day comes, the more mankind owes to the planet and future generations, and vice versa, the closer to the end of the year the date shifts, the less debt is.

According to GFN, the world population is using as much as 1.7 planets a year, a figure that is thought to increase to 2 planets by 2030. Yet, we only have one planet. It is needed to shift the Earth overshoot to December 31. The World Wildlife Fund stresses that to shift the Earth overshoot to December 31 it is needed firstly to reduce carbon dioxide emissions. Cutting $CO_2$ emissions by 50% would move the date to October. This will pay our "loan" to the planet and future generations for 3 months.




*Source:* National Footprint and Biocapacity Accounts 2021 Edition; data.footprintnetwork.org

# 12.4. The 2020 Hydropower Development: Global Trends

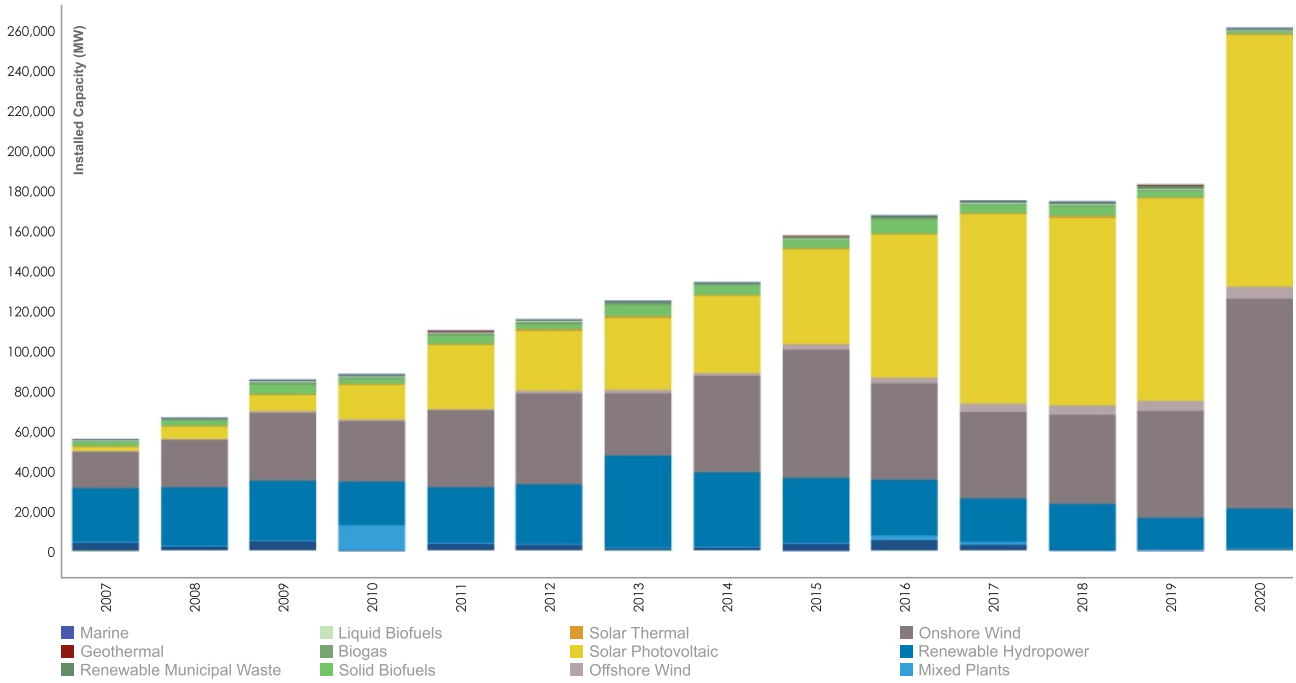
Policy brief compiled by Eugene Simonov, Rivers without Boundaries Coalition.

*This section provides a review of hydropower development in 2020 and rich statistics on hydropower in the 21 century. It notes a modest role of hydropower in renewable energy (RE) revolution, global decline in annual hydropower expansion for the last 7 years. Section contains a brief account of relative advantages and disadvantages of hydropower as a part of "sustainable development". It further assesses national policy environment for current hydropower development in dam-developing countries, exploring violations of internationally recognized ESG standards and safeguards. The report further explores sustainability at project level and contains overview of risks and potential damages for 90% of large hydro put online in 2020. Report has special part on pumped storage technology, possessing promising characteristics, which now faces uncertain future due to higher costs of construction and demonstrated lack of environmental safeguards.*

## Hydro has a modest role in renewable energy revolution

According to IRENA, in 2020 RE generation capacity increased by 261 GW (+10.3%) and amounted to 2,799 GW. Solar accounted for 714 GW with an increase of 127 GW (+22%) and wind energy reached 733 GW with 111 GW (+18%), continued to dominate RE capacity expansion, jointly accounting for 91% of all net RE additions in 2020. Hydropower capacity has increased by 20-21 GW (+2%), making global conventional hydropower reach 1,211 GW (not counting 121 GW of pure pumped-storage hydropower, which does not produce energy). Addition in hydropower in 2020 amounted to less than 8% of all increase in RE.

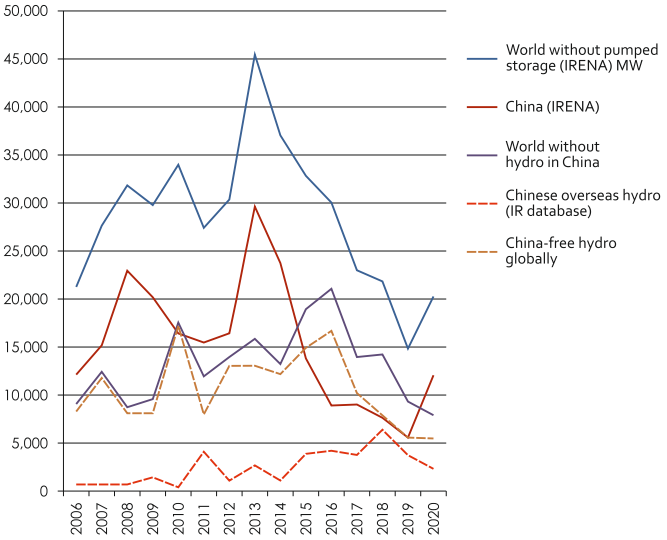
Figure 1: 2006-2020 Global annual additions of RE capacity (IRENA)

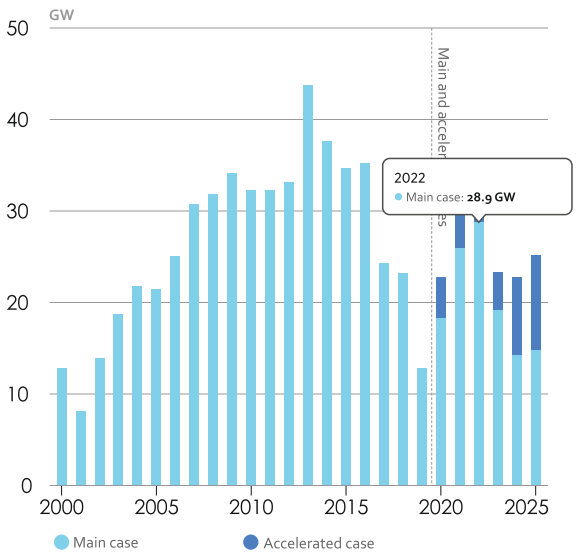



## Global hydropower expansion dynamics

We traced annual expansion of hydropower showing its relative decline during last 7 years. Figure 2 omits "pure" pumped storage plants, which are energy storage facilities and do not generate electricity. China has been the absolute champion responsible roughly for half of new hydropower globally and till 2019 displayed the sharpest decline in new hydro. Some increase in 2020-23 is due to completion of several megadams in China (Figure 3). At least till 2018 there was also an increase in capacity built with Chinese assistance in other coun-

Figures 2 and 3. Annual globally installed hydropower (International renewable energy Agency (IRENA) – left, International Energy Agency (IEA) predictions – right)

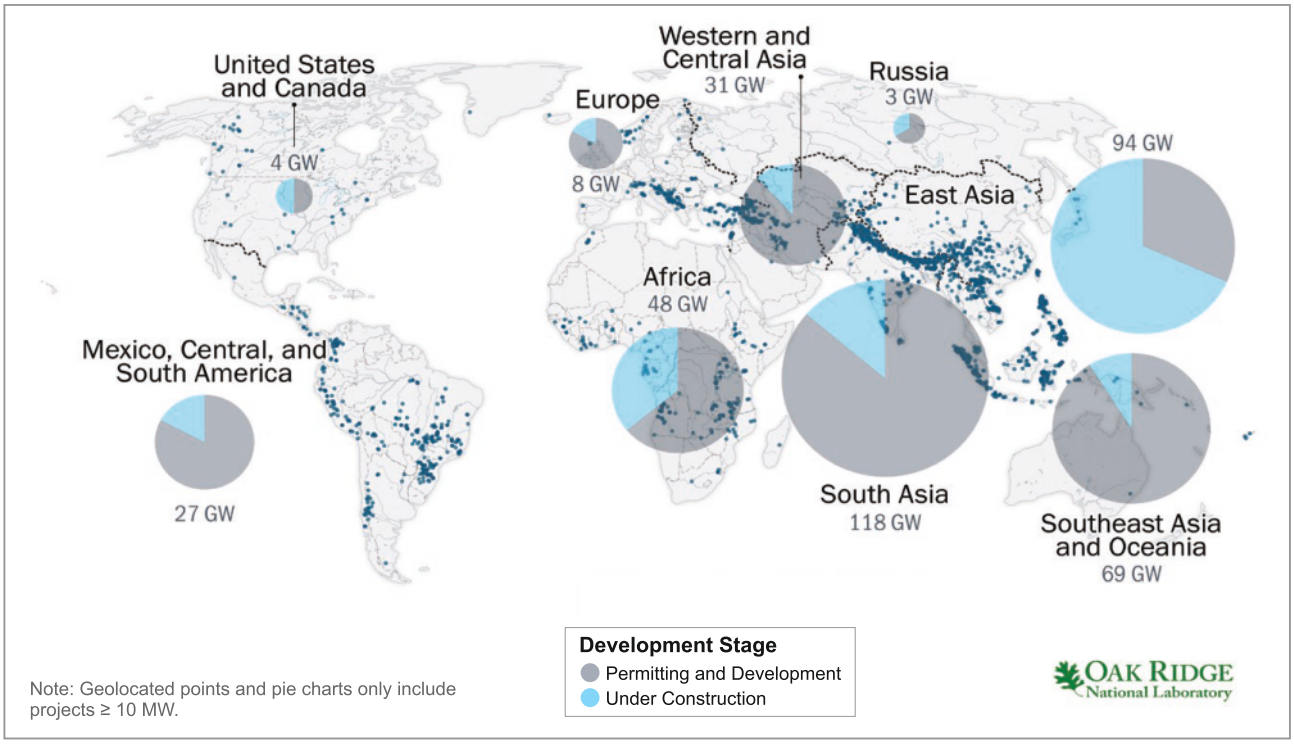


tries. Thus, in 2018-2020 more than 70% of hydropower capacity added globally was installed thanks to Chinese companies and financiers.

From 240 countries reporting on progress in RE to IRENA in 2020: only 46 countries added some hydropower capacity in 2020. (cf. *International Hydropower association (IHA) lists only 35 such countries, US Department of Energy (DoE) lists projects under construction in 66 countries as of December 2019*); 77 countries reported not having any hydropower (definitely not "energy for all"); 117 countries did not add any new capacity either through greenfield projects or upgrades; in 7 of those capacity decreased. Several countries deliberately removed from plans or restricted new projects (e.g. Bulgaria, Bosnia, Montenegro, etc.). All in all only 25-30 % of countries are developing new hydropower. The pace of greenfield hydropower development (comprising 4-7% of annual additions in new RE capacity) leaves it little chances to make any significant contribution to "the renewable energy revolution".

Figure 4. Map of "global hydropower pipeline"




*Source:* US DoE, 2021 Hydropower Market Report

According to the US DoE, the global development pipeline by the end of 2019 included 4,545 hydropower projects with total capacities of 414 GW. South Asia and Southeast Asia and Oceania have by far the largest number of projects – more than 600 each – but their average capacity is significantly lower than for the projects in East Asia. In total, at the end of 2019, 117 GW of hydropower were under construction in 616 projects across 66 countries. China accounted for 55% of hydropower capacity under construction (64 GW). Additionally, there were 297 GW of hydropower in different phases of scoping, permitting, and development.

US DoE claims that if all hydropower and pumped storage hydropower (PSH) investment projects in the global pipeline at the end of 2019 are completed, they represent an estimated expenditure of $1.1 trillion (of those, PSH projects required 270 billion). This total includes investment in new plants as well as expansions (e.g. addition of new turbine-generator units to existing plants) and refurbishments and upgrades (R&U) of existing units. It also includes both projects already under construction and those in the planning and permitting stages.

More than 90% of global expenditures are directed toward development of new plants. Tracked capital investment needs in plant expansions and R&U at the end of 2019 totalled $42 and $31 billion, respectively. If annual global expenditures for hydropower construction stay at $15-20 billion annually, then fulfilment of existing expansion plans will take 40-50 years. If alternatively we optimistically extrapolate into the future the development pace observed in 2015-2020, then 400+GW may be installed in 20 years. However, it would take 2-5 years to develop similar capacity using wind and solar projects at significantly lower costs.

The future of hydropower expansion is subject to **high uncertainty due to many critical factors** such as:

- increasing costs per kW installed capacity;
- increasing LCOE (price per KWh) in most countries of the world as opposed to rapidly decreasing LCOE of alternatives;
- much greater cost and time of project construction than for most other RE;

- high likelihood of time/cost overruns;

- acute conflict between hydropower projects and local communities, whose living environmental conditions and resources those projects degrade;

- decreasing availability of suitable sites at rivers located near electricity consumption centers;

- increasing risk of underperformance and catastrophic events due to climate change;

- huge negative impacts on biodiversity and ecosystem functions at planetary scale;

- increasing competition for water resources between all sectors of economy and overarching need to preserve key ecosystem services, that forces to prioritize water-use types, which have no practical alternatives (while hydropower has plenty of viable alternatives virtually everywhere);

- ageing dams around the world with mounting legacy problems and increasing risks of dam failures force responsible governments and companies to prioritize refurbishment and upgrades (and expansion) of existing facilities to greenfield development;

- already high proportion of hydropower in RE fleet in many developing countries makes their energy systems unbalanced and vulnerable to many problems listed above, forcing those states to expand other RE sources to make energy systems more reliable.

At the same time hydropower still has several **important selling points:**

- ability to provide manoeuvring capacity and other essential services to national energy systems and increasing recognition of their value by energy markets;

- still somewhat lower LCOE compared to most RE sources in some regions and low recurrent costs due to low water prices, lack of lasting compensation mechanisms for environmental and social impacts and, often, disregard to accumulating technical problems;

- corruption-prone model of dam development attractive for officials in countries with defunct governance systems;

- potential for multi-purpose use of reservoirs promises benefits additional to electricity generation, which is often not fulfilled once the dam is built;

- high symbolic value of dams making them focus of national development policies;

- inertia and self-preservation efforts of large construction and equipment-manufacturing industry focused on new hydropower development;

- inertia of multilateral and bilateral development finance institutions which prefer to support "large-scale" investment projects;

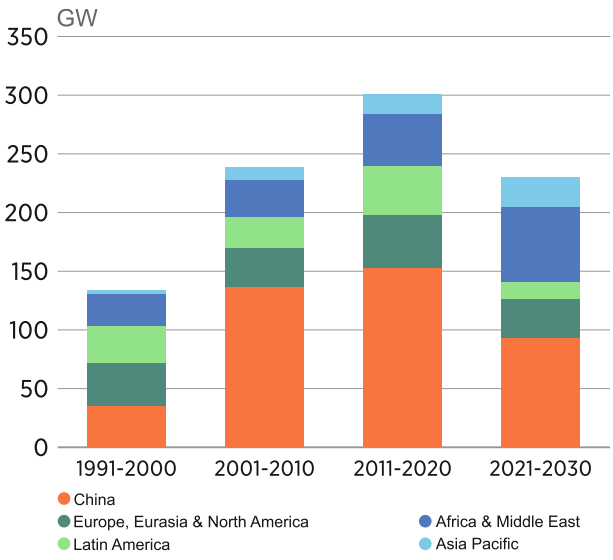
- longevity of projects: once built, a large dam may last for 60-120 years;

- highly questionable, but officially widely recognized "low-emissions" status of hydropower, which is partly due to poor accounting of climate-related trade-offs with disruption in ecosystem services and decline in biodiversity and, partly, due to disregard to time-bound climate targets when spreading emissions occurring at initial stages over the full-lifetime of the project.

Hydropower still has a huge appeal for variety of influential decision-makers and institutions and has a potential to persist in development agenda, especially in the context of strengthened authoritarian regimes and constrained access to decision-making both for expert community as well as civil society organizations and affected communities.

However even major proponents of hydropower development known for overoptimistic forecasts fully recognize that hydropower development globally has passed its peak and faces decline (Figure 5).

Figure 5. Hydropower statistics by regions and forecast till 2030 by the IEA




## Snapshot on hydropower installed in 2020 and trends behind it

Our analysis for 2020 is based on two annual reports: "Renewable Capacity Statistics 2021"[96] by IRENA and "Status of Hydropower Report" by the International Hydropower Association (IHA). We reviewed data on the countries adding more than 100 MW, according to at least one of two reports (Table 1). For either IRENA or IHA version our review covers 90% of capacity installed in 2020.

[96] https://www.irena.org/publications/2021/March/Renewable-Capacity-Statistics-2021

## Table 1. Countries installed more than 100 MW hydropower in 2020 ("Hydropower Champions")

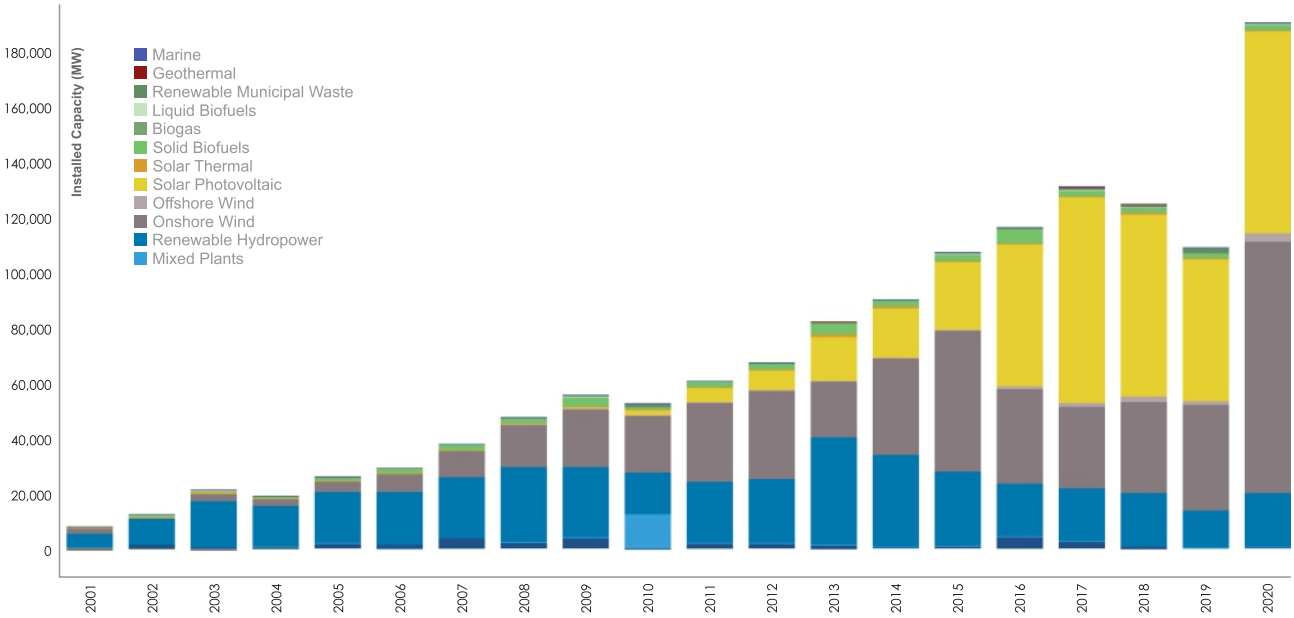
| Place | Country | MW Hydro installed | | MW PSH | Capacity added by specific power plants |
|---|---|---|---|---|---|
| | | IRENA | IHA | | |
| 1 | China* | 12,080 | 12,550 | 1,200 | 6,800/10,000 Wudongde, 1,200/1,800 Jixi PSH, 3 GW hydro in Yunnan province, etc. |
| 2 | Turkey | 2,500 | 2,500 | 0 | 1,200 Ilisu ,429 Cetin, 500 Lower Kalekoy, 120 Alpaslan II |
| 3A | Lao DPR** | 1,300 | 176 | 0 | 260 Don Sahong, 450? Three Nam Ou dams |
| 3B | Colombia* | 684 | 24 | 0 | Not specified (likely the IHA data correct) |
| 4 | India** | 478 | 478 | 0 | 300 MW Kameng, 99 Singoli Bhatwari |
| 4A | Austria | 550 | 0 | 0 | Of those 333 MW as mixed pumped-storage |
| 5 | Angola** | 333 | 401 | 0 | 400/2,070 Lauca completed |
| 6 | Russia* | 20 | 380 | 0 | 346 Zaramagskaya, 23 upgraded Irkutsk Hydro |
| 7 | Norway* | 200 | 324 | 0 | 78 Nedre Otta, 77 Leikanger and 48 Osterbo |
| 8 | Canada** | 5 | 275 | | 270 Lower Churchhill, 1st phase of Muskrats Falls Project (IHA) |
| 9 | Ethiopia** | 254 | 254 | | 254 Genale Dawa 3 |
| 10 | Indonesia** | 234 | 236 | | 120 Poso Peaker |
| 11 | Chile* | 251 | 205 | | 250 Alto-Maipo dam |
| 12 | Brazil* | 175 | 213 | | Not specified |
| 13 | Guinea** | 0 | 225 | | 225/450 Souapiti |
| 14 | Albania | 123 | 197 | | 197 Moglice |
| 15 | Georgia** | 178 | 178 | | 178 Shuakhevi |
| 16 | Honduras | 108 | 108 | | 104 Patuca III |
| 17 | Pakistan** | 102 | 102 | | 102 Gulpur |
| 18 | Nepal** | 121 | 74 | | 60MW Upper Trishuli 3A and 14MW Kulekhani III |
| 19 | USA* | 155 | 24 | | 36 Red Rock Hydroelectric Project |
| | TOTAL | 19,853 | 18,924 | | |

*Notes:* "A" marks difference between IRENA and IHA data. X/Y means that X MW was added to a project with Y full planned capacity.

*Legend:* * marks the countries shifting from overreliance on hydropower; ** marks the countries maximizing hydropower development; Grey filling – the countries that have recently experienced major economic or political problems due to high reliance on hydropower

Even among the leading countries hydropower is no longer the preferred type of RE expansion. Hydropower in 2020 contributed only 10% to the RE cumulative additions in all those 21 countries-champions (see Figure 6).

## Figure 6. The 21 countries "hydro-champions" in 2020 installed much more solar and wind energy than hydropower (IRENA)



However, real trends differ from country to country. In the table above, we used grey filling to highlight those countries, which had recently experienced major economic or political problems due to high reliance on hydropower (e.g. Georgia and Nepal have extreme seasonal deficit in energy generation forcing them to import energy from neighbours). We asterisked those countries, which despite large hydropower installation are explicitly seeking to move away from overreliance on hydropower (Brazil and Colombia being most recent examples).

A double asterisk is used to mark the countries, which pursue the opposite policy of maximizing hydropower development, despite best available evidence on related problems (e.g. Laos strangled by debts related to hydropower construction or Ethiopia risking political isolation due to its neighbours feeling threatened by development on transboundary rivers).

Those divergent trends, likely, will continue in future reinforced by external influences from larger countries and transnational corporations. The countries, which currently have the longest "hydropower pipelines", are not necessarily those having best technical or financial capacity to build hydro. Two thirds of the top 20 countries planning hydropower (Table 2) heavily rely on foreign hydropower firms, which open possibilities for increase in projects implemented overseas by Chinese, Turkish, Norwegian, Iranian, US, Russian and EU companies.

However, those development opportunities are met with growing restraint by international and domestic investors, a trend illustrated below (Fig.7) by data on Belt and Road Initiative finance.

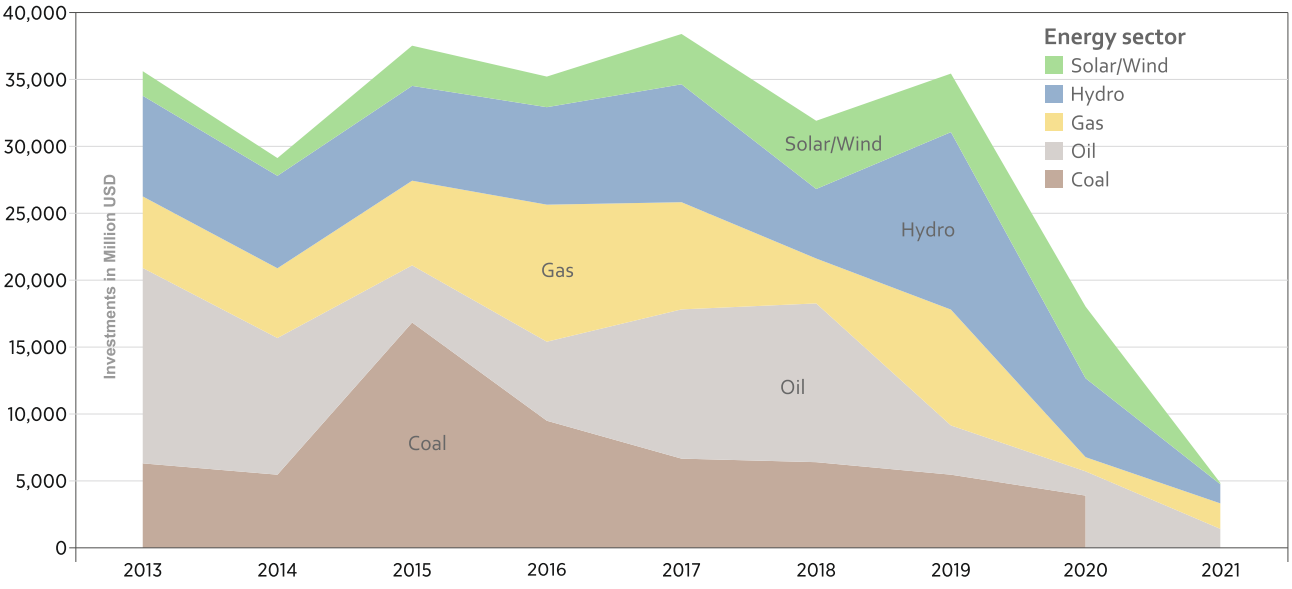
One of reasons for growing restraint in financing hydropower is rapid increase in cost of finance for hydropower, while it is falling for wind and solar.

Table 2. Top-20 "hydropower-planning" countries as of January 1, 2020

| Country | Hydropower Proposed (MW) |
|---|---|
| China | 92,937 |
| India | 41,995 |
| Nepal | 30,361 |
| Pakistan | 28,860 |
| Myanmar | 25,782 |
| Indonesia | 24,227 |
| Bhutan | 19,244 |
| Ethiopia | 12,419 |
| Brazil | 10,234 |
| Turkey | 8,534 |
| Lebanon | 8,100 |
| Iran | 7,997 |
| Laos | 7,796 |
| Philippines | 6,640 |
| Argentina | 5,722 |
| Tanzania | 4,541 |
| Angola | 4,418 |
| Peru | 4,137 |
| Nigeria | 3,762 |
| Zimbabwe | 3,653 |

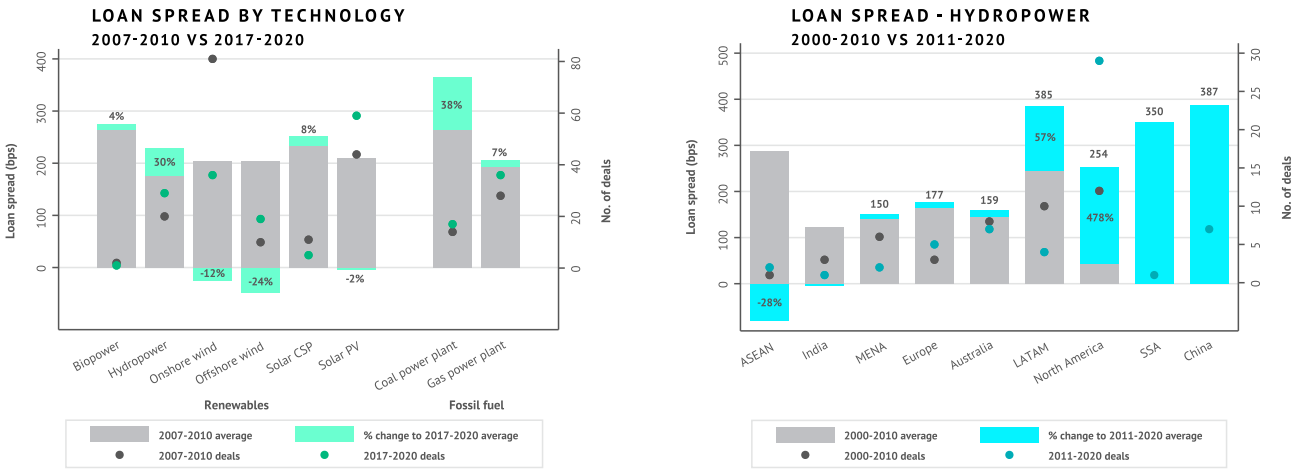
*Source:* US DOE, 2021 Hydropower Market Report

Figure 7. This chart from the China Belt and Road Initiative Investment Report published in July 2021 by Dr. Ch. Nedpoil Wang (GRBIC) China's overseas investments in large hydropower are in sharp decrease



A study published in April 2021 by Oxford Sustainable Finance Programme showed that over decade the financing costs for coal-fired power plants have increased on average by 38% and for hydropower by 30%, while for wind power and solar PV it was falling. The study also attempts comparison across regions, indicating dramatic rise in costs of hydropower loan servicing in Latin America and relative decrease in ASEAN countries.

Figure 8. Loan spread graphs show changes in cost of finance in energy sector




*Source:* Significant fall in cost of financing renewable energy projects. Oxford University

Oxford scientists examine financing costs by analysing syndicated bank loan spreads taken from LPC DealScan, which includes loan information on 12,072 loan deals between 2000 and 2020, involving 5,033 borrowers across 118 countries in the energy and electric utilities sectors as identified by The Refinitiv Business Classification (TRBC). Since the report primarily explores how the cost of debt for fossil fuels and renewables have changed internationally over the past 20 years it provides quite impartial assessment for hydro, since it is marginal to the author's interests and value judgements focused on fossil fuels.

Increasing attempts of hydropower industry to present hydropower as "green energy" are aiming at reducing cost of finance by granting to dam projects access to "climate finance" and "green bonds" markets. In 2020, the International Hydropower Association succeeded in issuing hydropower standard for "Climate Bond Initiative", which may give their members access to cheaper money to refinance hydropower projects.

## Persistent problems in hydropower development in champion countries

Unfortunately, modest development of greenfield hydropower in 2020 again came at the cost of destruction of irreplaceable natural areas and suffering of local communities in countries where those dams have been built. It also often exacerbated transboundary tensions, fuelled corruption and economic crisis. Using the River without Boundaries database we examined for which countries championing in 2020 we can present recent evidence of persistent generic problems in hydropower development policies and practices.

For all generic problems we marked by "1" serious threat/problem/impact inside a given country for which we have sufficient evidence within the last decade. Only in case of "transboundary waters conflict" we counted number of neighbours with which this country has a conflict/serious issue related to hydropower impacts[97]. We have evidence on serious unresolved conflicts with local communities, irreversible impacts on biodiversity, damming free-flowing rivers, economic problems caused by hydropower projects for more than 80% of championing countries. Significant transboundary impacts and conflicts are present in 14 countries out of 21 involved 32 additional countries.

China, as usual, heads the rating due to the scale of hydropower construction and 17 major basins shared with neighbours. Laos occupies the second place due to tremendous flaws in its aggressive hydropower expansion policies. India scores high due to its active promotion of domestic hydropower notwithstanding associated damage and acute transboundary water issues. Almost no information is available about Angola, which defines its low ranking. Norway has low ranking due to unique conditions for hydro on its naturally cascading rivers and high domestic governance standards. If we were also taking into account problems/impacts of overseas hydro supported by Norwegian firms and financiers, the scoring would be different.

This simple scoring exercise demonstrates that most of current hydropower development happens in countries not possessing at policy level sufficient safeguards and is associated with very high risks and potential damages. It clearly testifies to the fact that most of hydropower development in the world is unsustainable and proceeds at the expense of key sustainable development objectives.

[97] NB: We registered as transboundary both impacts excerpted by the country on its neighbors and impacts caused to this country by other riparian countries

Table 3. Hydropower related problems in 2020 hydropower champion countries

| Country | Conflict with Local Cultures | Biodiversity loss | Free flowing rivers dammed | Transboundary waters tensions (countries involved) | Corrupt governance | Major economic problems | Total score |
|---|---|---|---|---|---|---|---|
| China | 1 | 1 | 1 | 6 | 1 | 1 | 11 |
| Lao DPR | 1 | 1 | 1 | 4 | 1 | 1 | 9 |
| India | 1 | 1 | 1 | 3 | 1 | 1 | 8 |
| Turkey | 1 | 1 | 1 | 3 | | 1 | 7 |
| Ethiopia | 1 | 1 | 1 | 4 | | | 7 |
| Pakistan | 1 | 1 | 1 | 2 | 1 | 1 | 7 |
| Russia | 1 | 1 | 1 | 2 | | 1 | 6 |
| Canada | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| Nepal | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| Brazil | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| Colombia | 1 | 1 | 1 | | 1 | 1 | 5 |
| Indonesia | 1 | 1 | 1 | | 1 | 1 | 5 |
| Georgia | 1 | 1 | 1 | 1 | 1 | 1 | 5 |
| Honduras | 1 | 1 | 1 | | 1 | 1 | 5 |
| Guinea | 1 | 1 | 1 | 1 | | 1 | 5 |
| USA | 1 | 1 | 1 | 2 | | 1 | 5 |
| Albania | 1 | 1 | 1 | | | 1 | 4 |
| Austria | 1 | 1 | 1 | | | | 3 |
| Chile | 1 | | 1 | | 1 | | 3 |
| Angola | | | | 1 | 1 | 1 | 3 |
| Norway | | | 1 | | | | 1 |
| TOTAL | 19 | 18 | 18 | 32 | 13 | 17 | |
| % | 90.5 | 85.7 | 85.7 | | 61.9 | 81.0 | |

## 2020 hydropower expansion in selected countries and its costs

### EURASIA

#### China

Almost two thirds of globally installed hydropower (12.5GW) was added in China, where hydropower capacity reached 370 GW, wind power - 280 GW and photovoltaic – 250 GW. In 2020 most of increase accounts for completion of a giant 10 GW Wudongde Dam and greater addition is expected in 2021-23 due to completion of the 16 GW Baihetan dam on upper Yangtze River (Jinshajiang). As a result of 50 years of dam building and poorly coordinated development the ecosystem of the Yangtze River is in crisis and many of its 250 fish species face decline and extinction. The giant Chinese paddlefish was recognized as extinct due to dam construction and overfishing. In 2020 China adopted a special law on conservation of Yangtze River, but hydropower companies lobbied to remove prohibition on new dam building, present in early drafts.

Responding to the UNESCO inquiry on hydropower plans near "Three Parallel Rivers of Yunnan" protected area, China confirmed that damming plans for Lancang (Mekong) and Jinsha (Yangtze) rivers will proceed "as planned", which means further encroachment into fragile mountainous areas and retention of greater water volume in reservoirs with detrimental effects for downstream ecosystems. In late 2020 China also revealed a plan to develop 60 GW hydropower dam in Tibet on Yarlung Tsangpo (Brahmaputra) River right before it leaves for India and Bangladesh. Such plans create extreme tensions between countries and may destroy traditional lifestyle of indigenous minorities.

In 2020 China installed 48 GW of photovoltaics and 73 GW of wind capacity. The annual increase from wind power generation exceeded that from hydropower despite extreme floods on major rivers of the country. Already having the greatest hydropower fleet China, obviously, could substitute new hydropower construction by less destructive alternatives, but it still plans building new dams on transboundary watercourses to strengthen its strategic advantage over downstream neighbors.

#### Turkey

With 2.5GW added capacity, Turkey holds the second place in hydropower installation in 2020, largely due to putting in full operation the infamous Ilisu Dam on the Tigris River. The project blocks the Tigris River, destroying important biodiversity and displacing up to 50,000 people, the majority of whom

are ethnic Kurds. It submerged the ancient town of Hasankeyf, one of the world's oldest continuously inhabited settlements and threatens water security of Iraq as well as the Mesopotamia Marshes World Heritage. Turkey repeatedly creates artificial water scarcity to pressure and intimidate its downstream neighbours in Syria, Iraqi Kurdistan and Southern Iraq. In Syria this led to dysfunction of hydropower plant on the Euphrates.

### Lao DPR

Laos put on line phase II dams of the Ou River cascade, the Nam Ou #1, 3 and 4 dams. The cascade has been developed under a Build-Operate-Transfer (BOT) arrangement, and PowerChina will operate the dams for 25 years before handing them back to the Laos State Electricity Corporation (EDL). The construction of the dams has been controversial for the loss of biodiversity and sources of food in the river basin. Resettlement is also an ongoing, difficult process, even according to Lao media reports. Hydropower cascade on the Ou River together with Luang Prabang Hydro being built on the main stem of Mekong also may negatively affect the Luang Prabang World Heritage city at the confluence of those two dammed rivers.

Altogether, the country installed in 2020 anywhere from 0.5 to 1.3 GW in the Mekong River basin, which unique ecosystem it purposefully destroys in an attempt to become the "battery of Southeast Asia". However, instead of a triumph, the country in 2020 faced prospects of a debt-default and declining demand for its energy from irritated riparian neighbours. In 2020 Laos was forced to cede the EDL into concession to a China Southern Grid Co. This demonstrates that over-development of hydropower mega-projects may lead to partial loss of sovereignty by smaller states.

### India

In January 2021 Minster of Energy of India declared that the reason for delay in hydropower construction is civil society movements sabotaging development of the country.

India, according to both IRENA and IHA, installed 480 MW or less than 3% of 20 GW it hopes to add by 2030. However, India's own official statistics shows addition only of 399 MW. The largest new facilities put on-line were the 300 MW Kameng HEP in Arunachal Pradesh, a project associated with significant corruption, fraud and massive cost/time overruns. Another addition – the 99 MW Singoli Bhatwari Hydro – comes with questionable environmental clearance and is also facing a tunnel leakage issue. This project was massively damaged in the June 2013 Uttarakhand disaster, which, unfortunately, has not served a lesson to responsible agencies. In 2020 – early 2021 many people were killed in several accidents, greatest of them being a new catastrophic landslide in Uttarakhand, affecting many dams under construction in an area which scientist long before declared off-limits of large infrastructure development. The IHA reports that the Government also granted approval to proceed with the giant Dibang project (2,880 MW), which is predicted to cause major destruction of biodiversity and violation of human rights.

Responding to a "Covid-19 vigil" initiated by the Prime Minister of India, who encouraged households to switch their lights on and off, hydropower producers had to ramp down and up within seconds to support the unprecedented 31 GW shift in electricity demand. Fortunately this reckless authoritarian experiment has not caused any major failures, but it has not been effective in preventing spread of COVID either.

### Indonesia

With a pledge to reach 23% of RE share by 2030 the Indonesian government has clearly disadvantageous focus on hydropower, which creates many new conflicts with biodiversity conservation objectives and well-being of local communities. Among 236 MW added in 2020 the largest project is 120 MW "Poso Peaker Hydro" on the island of Sulawesi, where the company belonging to the family of the former Vice-President Joseph Kalla is degrading the unique ancient lake Poso – a cradle of freshwater biodiversity and depriving local communities of their traditional fisheries and cultural monuments. On the island of Sumatra the government vehemently supports construction of a Batang-Toru Hydro by Zhefu Holdings and Power China-Sinohydro, which may wipe-out newly-discovered ape species – Tapanuli orangutan from the only known habitat.

### Pakistan

In 2020 Pakistani military construction company started cooperation with Chinese SOEs and consortium of western consultants-enablers to develop the Diamer Basha Dam, which is the largest and likely the most controversial project in the transboundary Indus River basin. A 100 MW Gulpur Project was completed on the Poonch River, which was once considered the most ecologically sensitive river in the Azad Jammu & Kashmir, which makes a dam siting in a Masheer national park completely not justifiable. Nevertheless the IFC, ADB and other international players heavily invested in this private-public partnership project and claimed that resulting design helps to achieve "net biodiversity gain in critical habitat" (based on condition "if everything goes as prescribed"). This bad precedent provided excuse for further sacrifice of similar "critical habitat" in the Kunhar River near Balakot City, where in 2020 loan were granted by the ADB and AIIB to finance construction of a 300 MW hydropower plant.

### Nepal

Nepal likely has the largest ratio of stalled hydropower projects per unit GDP. It was hit hard by COVID-19 lockdown, because it depends heavily on Chinese and Indian labor and technology to build hydro. Hydropower construction severely affects indigenous people of the mountains and charismatic wildlife, including freshwater Gangetic dolphins. The country is trapped by hydropower lobby that effectively prevents diversification in solar and other RE badly needed by local economy.

### Georgia

Georgia added a 178MW Shuakhevi Hydro, developed by Norwegian "Clean Energy Invest" and Indian "Tata-Power". Actually this plant was completed in 2017, but collapsed right after the start of operations due to malfunction of the plant's derivation tunnels, which pass through local villages. At least three other projects collapsed or failed during the last decade.

Poorly planned projects stalled by popular wrath dot the landscape, but the government moves on marketing new river stretches to new foreign developers. The latest massive protest campaign against the Namakhvani dam cascade built by the same Norwegian company and Turkish firm ENKA on Rioni River has resulted in halt in construction in March 2021 and 30000-strong anti-government manifestations in the city of Kutaisi located downstream from the planned dam. This construction also has potential conflict with a World heritage property downstream.

### Austria

According to IRENA, Austria installed 550 MW, from those 333 MW came in mixed hydro/pumped storage facilities. In 2020 WWF-Austria and other groups protested against illegal construction of the Tumpen-Habichen Power Plant built on the free flowing Ötztaler Ache River, which started in secrecy under cover of Corona virus curfews, while legal complaints were still pending.

### Albania

Norwegian Statcraft completed the 197 MW Moglice project as a part of a cascade on one of the last free-flowing rivers of Europe. The European Commission urged the country to diversify its power portfolio, saying its dependence on hydropower could have severe consequences for the power supply during times of drought. After the Energy Community sent a legal inquiry on the HPP Pocem project awarded to a Turkish Company without a tender, the Albanian Government withdrew permits for all hydropower projects on the free-flowing Vjosa River and said it plans to integrate the area into the Vjosa national park.

## AFRICA

### Guinea

Guinea installed 225 MW at the Souapiti Hydropower Project located on the Konkoure River, with a total installed capacity of 450 MW. This project was constructed by China International Water & Electric Corporation (CWE – subsidiary of China Tree Gorges Group) and is expected to cost about $2 billion. According to a report by the Human Rights Watch the dam's reservoir will ultimately displace an estimated 16,000 people from 101 villages and hamlets. It will flood 253 square kilometers of land, including an estimated 42 square kilometers of crops and more than 550,000 crop-bearing trees. Displaced populations will have less favorable land than they have been farming for generations and dozens of already displaced residents interviewed by the Human Rights Watch say that they are already struggling to find adequate food for their families. Meanwhile, a failure to expand capacity of the transmission line connecting Souapiti and Kaléta with Conakry has left large amounts of new generation stranded and Electricité de Guinée in returning loans to Chinese banks.

### Ethiopia

In Africa Ethiopia is a champion in building hydropower that destroys key natural assets and community livelihoods on transboundary rivers. It connected to the grid 254 MW Genale Dawa III, financed by Chinese banks and assisted by Chinese contractors (somehow the IHA reported it twice in 2019 and 2020). The dam will entail significant impacts on Somalia, severely restricting flows into Somalia's Juba River. The Juba is one of only two perennial rivers in Somalia, and it accounts for most of the country's agricultural production. The Genale Dawa III is expected to reduce the Juba's flows by between a quarter and a third, with major consequences for Somalia's food security.

The Grand Renaissance Dam (6,000 MW) on the Nile completed the first stage of filling its reservoir in July 2020 with 4.9 billion cubic meters of storage and threatens both Egypt and Sudan, who actively develop international coalition to press Ethiopia to commit to a legally binding agreement on the amount of water retained in the reservoir and schedule of downstream flows.

In Kenya a Lake Turkana was put on the "World Heritage in Danger" List due to destructive impacts from a dam built by Ethiopia on Omo River and in 2021 UNESCO still requests in vain Ethiopia and Kenya to jointly present a Strategic Environmental Assessment and develop safeguards against further degradation.

## THE AMERICAS

### Colombia

The country is best known for the 2.4 GW Hidroituango project, which was developed on the free-flowing Cauca River with rampant violations of human rights and multiple murders of local activists. Construction was stalled in 2018 by a giant landslide, creating threat of dam failure, which caused displacement of 12,000 people from downstream settlements. The IHA Report notes that the Inter-American Development Bank in 2020 approved an extra US$900 million to salvage/finish the Ituango project, while Export Development Canada publicly stated they regret participation in financing this dam. Following this incident Colombia revised its energy development program to avoid overreliance on hydropower, thus we doubt accuracy of the IRENA report of 680 MW of new hydro. However, in 2021 placement of wind farms proceeds with violations of indigenous peoples' rights similar to those in case of the Ituango project.

### Chile

Chile by January 2021 connected to grid the 251 MW Alto-Maipo dam built by US AES Corporation with many violations of community rights, which may jeopardize Santiago's drinking water to benefit a mining tycoon. In July 2020 the Independent Consultation and Investigation Mechanism concluded in its report on the Alto-Maipo Hydroelectric Project that the Inter-American Development Bank (IDB) breached its policies, since the company implementing the project failed to: carry out any assessment of gender-differentiated impacts, despite the large number of workers brought into the Maipo River Valley; evaluate the impacts of the project on recreational uses of the river; and assess the impact of the project on cattle drivers, among other issues. A similar judgement from the IFC's CAO mechanisms is expected on July 6, 2021. Both come too late to serve justice to communities affected by this ill-designed project.

### Canada

The Lower Churchill Dam, the 1st phase of the Muskrats Falls Project in Labrador entered textbooks on environmental risks long before its first turbine was connected to grid. The project that is billions over

budget and years behind schedule, at a final forecast will cost more than $13 billion. Local Inuit people resisted the flooding by the 834 MW dam arguing it will contaminate the area with methylmercury. The company continued with the project and flooded the 41-sq-km reservoir. The Innu Nation of Labrador announced on October 6th 2020, that it is seeking $4 billion in damages from Hydro-Quebec over this mega-dam. The suit, filed in the Supreme Court of Newfoundland & Labrador, seeks compensation for the theft of ancestral Innu land in 1967 to build the Churchill Falls hydroelectric project. Another prominent case in Canada is "Site C" hydropower construction progressing on the Peace River in British Columbia that will greatly increase disruption of flows to the Wood Buffalo World Heritage site and lands of indigenous people. After a request from the World Heritage Committee the Government of Canada completed a strategic environmental assessment, which confirmed detrimental effects, but failed to undertake decisive steps to prevent damage.

### Honduras

Honduras and Sinohydro Co. have put in operation the 106 MW Patuca III Hydro, which for a decade has been of outmost concern due to its potential impact on Rio Platano World Heritage site that was recognized as "Heritage in Danger". In early 2020 Honduras reported that the Patuca III HPP has been completed to 97% and the reservoir was filled at 81.3%. In 2021 the World Heritage Center noted with serious concern and regret that construction of the Patuca III HPP is now essentially completed without a proper assessment of the current and potential impacts of the project on the World Heritage property. It requests that a strategic environmental assessment to be urgently expedited to assist putting in place the necessary measures to mitigate adverse impacts on the property.

Besides that, Honduras is widely known as a country where hydropower builders employ assassins to get rid of local activists. The story of indigenous Lenca leader, Berta Caceres assassination has become widely known globally, but it has not stopped the local practices. Twelve indigenous and environmental activists were killed in 2020. The last victim Cerros Escalante, shot on March 22 2021, led a local group called "Communities United," was active in hamlets near the Rio Ulúa and opposed the El Tornillito hydroelectric dam.

### United States

The only sizeable new plant we could discern in the USA was the 36 MW Red Rock Hydroelectric Project mounted on pre-existing dam. So, likely, the rest from 157 MW reported by IRENA came from upgrades and expansion of existing hydro. Statistics shows that hydro makes about 0.4% (by capacity) in new electricity project pipeline at the end 2020, and proposed pumped storage makes less than 2% of storage projects in the pipeline, with 98% occupied by batteries.

The projects listed above together make up 90% of global hydropower installation in 2020[98]. Hardly 10% of projects put on-line do not have notable flaws, which make them inherently unsustainable and dangerous. Exactly the same trend was observed about projects completed in 2019 in the review presented in the Rivers for Recovery Report. Thus we see perpetuation of unsustainable pattern of destructive hydropower development without effective attempts by the industry to stop it.

## Welcome the pumped storage…

As for the pumped storage hydro (PSH), much hyped as a remedy for grid stability and flexibility, which also usually has less destructive footprint, only 1,633 MW were put in operation in 2020, despite all hopes trumpeted by hydropower industry and personally by former Australia PM Malcolm Turnbull. In practice this means that most countries balance uneven output of 'variable renewables" by other means ranging from building batteries to smart use of large grids (See Hydropower Market Report with such analysis for the US hydro and PSH).

A map published by the US DoE shows the global PSH pipeline as traced by US Oak Ridge Labs (Figure 9). The global development pipeline by the end of 2019 included 284 PSH projects with total capacities of 226 GW. At the end of 2019, according to the US DoE, 13 countries were constructing 50 PSH projects with total capacity of 53 GW. Additionally, there were 173 GW of PSH in different phases of scoping, permitting, and development.

Almost everyone agrees that in principle the PSH is the most promising of all hydropower technologies. Researchers from the Australian National University developed geographic information system algorithms to catalogue potential closed-loop[99] PSH sites around the world. In 2019, they published a global atlas of the 616,000 locations identified in their analysis, with a combined energy storage capacity of approximately 23 million GWh (http://re100.eng.anu.edu.au/global/). Although only a small portion of the identified sites would ultimately be viable once more detailed geological and environmental studies are conducted, the authors estimate that developing as few as 1% of the identified energy storage capacity would be enough to fulfill the storage requirements of a global grid with 100% renewables. However, something is preventing the PHS from developing at pace corresponding with needs of RE development. An average 2.3 GW was developed annually since 2005 without any increase (Figure 10).

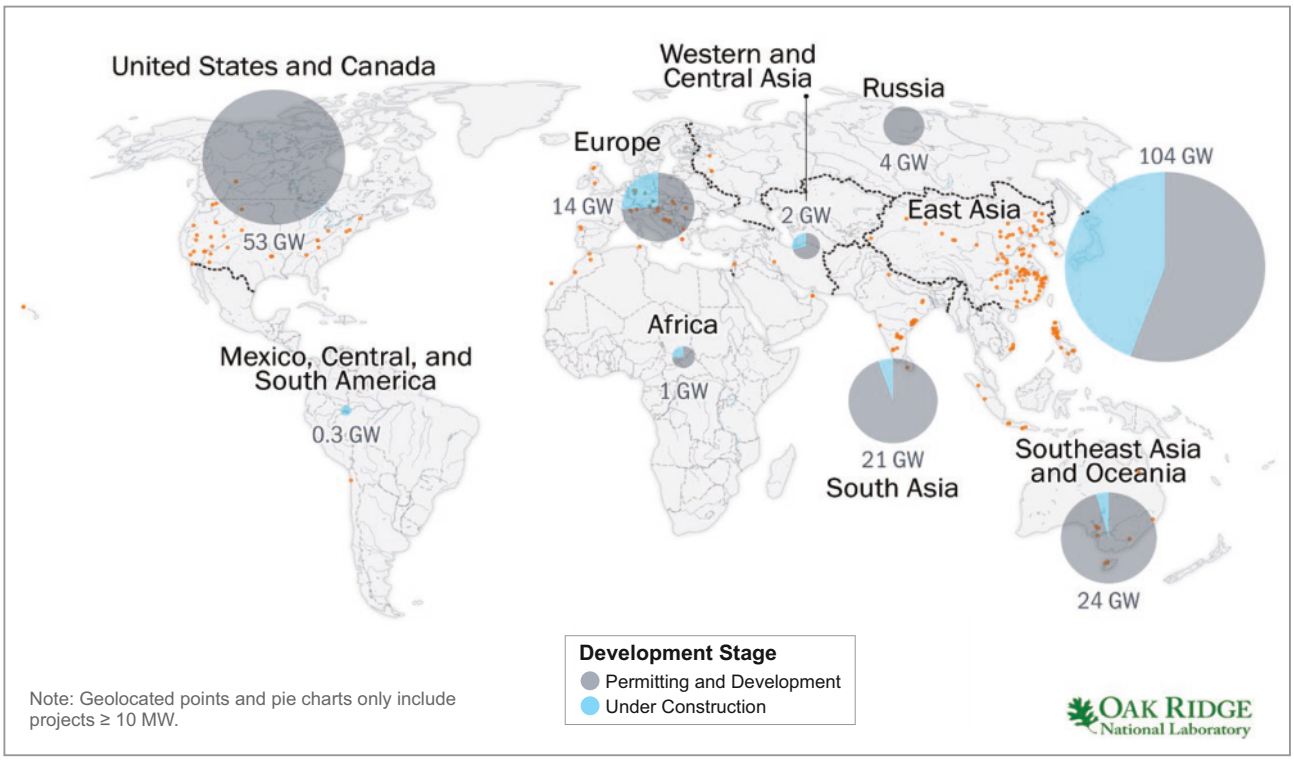
China accounted for 87% of PSH planned capacity with 46 GW under construction. Only 1.2 GW were installed in 2020 as three turbines at the Jixi Pumped Storage in 2020. China's 13th year plan is ending with completion of less than 40% of planned 35 GW expansion of PSH fleet. China PSH pricing mechanism released in April 2021 suggested all pumped storage plants in China to adopt a two-part tariff mechanism based on capacity and energy tariff after 2023.

Other 300 MW was installed in northern Israel at Gilboa PSH and, according to IRENA, 115 MW were added in the United States.

[98] Disclaimer: By not mentioning smaller contributions to hydropower installation, we by no means imply that smaller hydropower does not cause environmental harm. It is equally harmful and to rivers where dams are built and similarly impinges on rights of communities living on those rivers

[99] "Closed-loop PHS" presumes that neither upper nor lower reservoir is developed by alteration of natural stream or lake

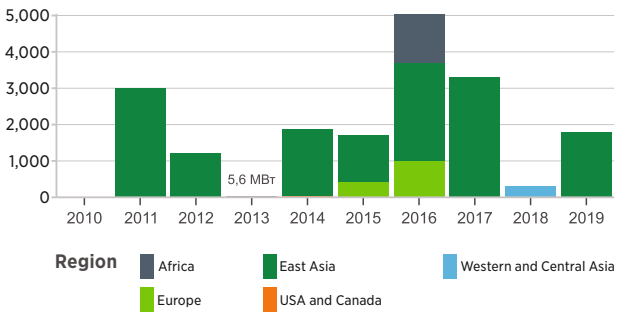
Figure 9. Map of global PSH pipelines




*Source:* US DoE, 2021 Hydropower Market Report

As for environmental and social impacts, relatively few concerns have been voiced in relation to the PSH projects. Decades ago Russia proposed a 1 GW PSH in Tver Region which would negatively affect the Tsentralno-Lesnoy Strict Nature Reserve, but that proposal long ago faded away without a trace. Australian PM Turnbull authorized an irresponsible scheme of 2 GW PHS development called Snowy-2, based on existing hydro inside the most iconic Kosciusko National Park of Australia, which was planned and pushed through EIA without credible mitigation measures. Now this unfortunate development will serve as repellent for investors into this otherwise benign technology. Project pipeline advertised by investors includes new large PSH projects presenting high unassessed potential threats, such as "Battery of the Nation" Scheme encircling Tasmania Wilderness World Heritage Site in Australia and several dams proposed on indigenous lands upstream of Grand Canyon World Heritage in the USA.

Figure 10. PSH installation over last decade has been uneven




*Source:* US DoE, 2021 Hydropower Market Report

Less than 2 GW of PSH added globally in 2020 may signify that this technology is still less attractive than battery and grid-based solutions to boost energy system flexibility. Given fresh experience with the irresponsible Snowy-2 project civil society and environmental organisations, would be less eager to speak in support of this technology. To regain popular support the pumped hydro proponents need to adopt the strictest environmental and social standards, especially for site-selection planning process, and demonstrate in practice that this technology enables RE revolution without destruction of nature and does not present just another unsustainable business as usual.

## Conclusion

This report demonstrates that most of current hydropower development happens in countries not possessing at policy level sufficient safeguards and is associated with very high risks and a potential damage, which is vividly exemplified by 90% of large hydro, put online in 2020. Financial viability of hydropower projects has been rapidly decreasing due to increasing construction and energy production costs as well as increase in cost of capital. Climate resilience of existing hydropower fleet happened to be lower than expected with many countries suffering from overreliance on hydropower in times of droughts and large floods. The industry is still trying to overcome difficulties by exploiting "climate" theme in an attempt to capture cheaper climate finance and has made some progress with support of the "Climate Bond Initiative".

Pumped storage hydropower technology, despite its promising characteristics, faces uncertain future due to higher costs of construction and lack of environmental safeguards displayed by its flagship project "Snowy-2" in Australia. However, closed-loop pum-

ped storage built outside of sensitive natural areas still has a chance of revival, given vast choice of potential locations available on each continent. It is unlikely to regain credibility unless its environmental and social impacts are subjected to analysis and public discussions from early stages of project identification.

*Key references*

International Rivers and RwB 2020. Rivers for Recovery Report. https://www.rivers4recovery.org/

US DoE, 2021 Hydropower Market Report. https://www.energy.gov/eere/water/hydropower-market-report

International Hydropower Association 2021. Status of Hydropower Report. www.hydropower.org

IRENA 2021. Renewable Capacity Statistics 2021" https://www.irena.org/publications/2021/March/Renewable-Capacity-Statistics-2021

Oxford University 2021. Significant fall in cost of financing renewable energy projects. https://www.smithschool.ox.ac.uk/news/articles/210419-significant-fall-in-cost-financing-renewable-energy-projects.html

United Nations University Institute for Water, Environment and Health (UNU-INWEH). "Ageing Water Infrastructure: An Emerging Global Risk" https://inweh.unu.edu/ageing-water-storage-infrastructure-an-emerging-global-risk/

Hydropower in the European Green Climate Finance Taxonomy. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12302-Sustainable-finance-EU-classification-system-for-green-investments/F1345685_en

# 12.5. Sardoba Dam Collapse

## General Information

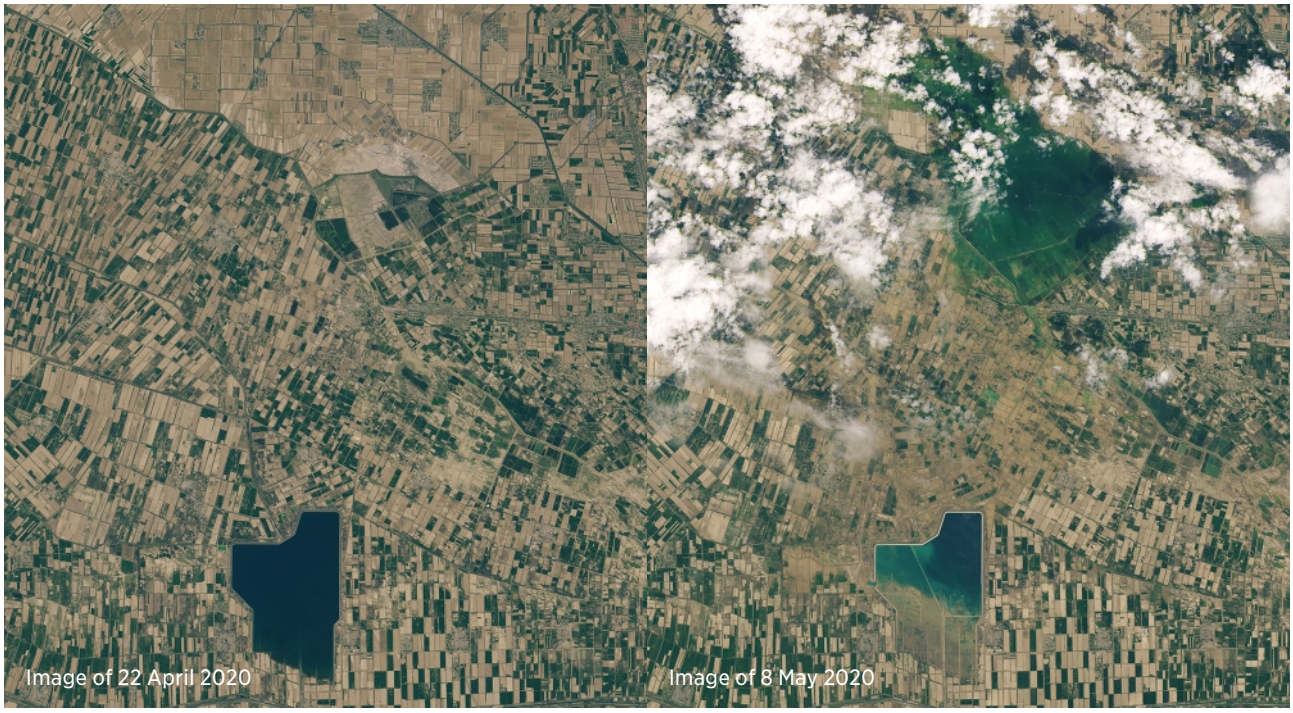
The Sardoba is a reservoir built to supply irrigation water to six districts in Syrdarya and Djizzak provinces of Uzbekistan. The total capacity is 974 mcm, including the useful capacity of 922 mcm. The reservoir's perimeter is 42 km; the dam's length is 28 km, and, the area is 6,800 ha. The reservoir is 28.8 meters deep. The maximum dam height is 33 meters, with the maximum water level of 30 meters.

Construction of the reservoir in the territory of Sardoba, Mirzaabad and Khavast districts began in 2010 following the Governmental Decree and was completed in 2017. By January 2017, the total cost of construction reached 1.3 trillion soums ($404.4 million). The customer of the facility was the State unitary enterprise "Sirdaryosuvkurilishinvest" of the then Ministry of Agriculture and Water Resources. The Project designed by OOO "UzGip" was implemented by State unitary enterprise "Uztemiryulkurilishmontazh" of the Uzbekistan railways company.

Based on satellite imagery, accumulation of water started in winter 2013/2014 and by 30 April the reservoir was almost filled, with the water volume exceeding the maximum design values. Constriction of a small 10.7 MW hydropower plant at the reservoir was started in April 2020. The plant designed for generation of 41.1 MkWh is to be completed by the end of 2022.

## Dam burst and flooding

On the 1st of May, the dam burst. The poured water was turned to the Abay Canal in the Akaltyn district and then into the Arnasay lake system in Djizzak province. The gates were also opened so that water could flow into the irrigation canal network. As a result of inflow of 180 $m^3/s$, the Central Golodnostepskiy Collector, given its flow capacity of 120 $m^3/s$, was overfilled with water, with the resulting flooding. The water surface area of the reservoir halved, while the water volume decreased by more than 70%.




The flooded area based on Sentinel-2B imagery of 04.05.2020, 06:27 GMT. The red line shows the zone of flooding. The red tag indicates to the dam burst point. The blue lines indicate to settlements in the flooding zone.

*Source:* A.M. Konstantinova, Ye.A. Lupyan. Analysis of the consequences of the Sardoba dam burst on 1 May 2020 (in Russian) // Current issues of remote sensing – 2020 – V. 17, No. 3. – pp. 261-266.

## Effects and emergency relief in Uzbekistan[100]

The flood critically damaged settlements and crops in the Sardoba, Akaltyn and Mirzaabad districts. Buildings, roads, and communications were flooded. More than 90 thousand people had to be evacuated from 23 villages in the three districts; 56 people were hospitalized; 4 people died.

Shavkat Mirziyoyev at the Sardoba reservoir.
Source: Press-service of the President of Uzbekistan

As reported by the Ministry of Emergency Situations of Uzbekistan, 32,381 hectares were damaged by flooding in the above districts. 23 settlements, 4,711 domestic buildings and 277 non-residential buildings, as well as 30,718 hectares of cropland were affected. Preliminary figure of damage from flooding was more than $4.3 million.


Source: https://kun.uz

Source: https://uz.sputniknews.ru

A special governmental commission was formed for emergency relief. A territory over 2 $Mm^2$ was disinfected in 12,485 dwelling buildings, 748 shops, 304 administrative buildings, 31 markets and 540 roads. In order to improve the environmental situation, 6,086 t of wastes and 13,620 t of floodwater were removed from the affected area. Flood damaged roads and electric and gas networks were repaired.

Leading international experts from France, Turkey and Russia were invited to make an external expertise of this technogenic catastrophe.

[100] Source: https://www.gazeta.uz, https://kun.uz, https://nuz.uz, http://www.prokuratura.uz

The law enforcement agencies have opened a criminal case on the Sardoba dam against 17 persons, including the client (GUP "Syrdaryo Kurilishinvest"), the designer (OOO "Uzgip"), the main contractor (UP "Uztemiryolkurilishmontaj"), contractors (Rezaksoi Suv Kurilish, Omad Dubl, Sariosiyo kurilish, Trans Servis Complex, Topalang Sherobod), and officials of the Uzbek Ministry of Water Management and the Operations Administration.

As the Prosecutor General's Office reported, the dam burst was caused by mistakes and defects in project design, construction and operation. Proceedings were initiated for a number of articles, including stealing, breach of water use, abuse of authority, neglect of official duty, forgery in public office, and violation of safety rules during construction. The Supreme Court of Uzbekistan started holding hearings in private on 21 December 2020 and passed a sentence upon 17 persons on 10 May 2021.

## Effects and emergency relief in Kazakhstan[101]

In the Kazakh territory, 5 settlements (Zhanaturmys, Zhenis, Firdousi, Dostyk, and Orgebas) that were home to 6,211 people have been flooded in the Makhtaaral district. 1,030 residential buildings, 3 schools, 5 kindergartens, 4 health-care buildings, 10 trade points, roads, a bridge and 5,695 ha of agricultural land were flooded. The damage from flooding amounted to 31.7 billion tenge. There were no human losses.

The flooding area was mapped, and ambulance and rescue services were set in motion. In total, 1,635 persons, 297 machines, 17 boats and 220 motor pipes were deployed in rescue operations.


Source: https://kursiv.kz

Additional forces were deployed from Almaty, Kyzylorda, Zhambyl provinces and Shymkent. 223 specialists, 62 units of equipment, 100 units of water pumping equipment were sent from Uzbekistan for help. 30,606 people and 15,171 heads of domestic animals were evacuated from flooded and endangered settlements.

A total of 11,798,000 l of water have been pumped out to safe areas. 931 dead domestic animals (mainly from the territory of Uzbekistan) were extracted from water. An area of 2.8 $Mm^2$ was decontaminated.

Since a state of emergency was declared, the Government of Kazakhstan allocated 552 million tenge to 5,524 residents of 5 settlements affected by the accident, with each resident getting 100,000 tenge.

Additionally, the Fund of Alisher Usmanov transferred $1000 to each of 5,318 personal accounts of families living in 5 affected villages and 8 evacuated settlements (Myrzakent, Zhailybaev, Nurlytan, Shugyla, Zhantaksai, Nurlyzhol, Arayly, Akzhol).

## Cooperation between Uzbekistan and Kazakhstan

Immediately after the accident, it was reported that Kazakhstan was preparing a note for the Uzbek Foreign Ministry and would demand compensation for damage. But on 5 May, the Kazakh Foreign Ministry claimed that sending of the note to Uzbekistan was no longer in question, and the parties jointly planned recovery. Uzbekistan quickly provided more than 150 units of equipment and more than 200 specialists to help eliminate consequences of the accident in the territory of Kazakhstan. Kyrgyzstan and Tajikistan also provided their help. In the course of the year, Kazakhstan and Uzbekistan closely coordinated the recovery operations: regular contacts were maintained between the heads of state and governments of the two countries. Environment Minister Mirzagaliev of Kazakhstan and Water Minister Khamraev of Uzbekistan met several times. The parties negotiated a draft Agreement on joint management and use of transboundary waters (see more details in Meetings of the Working Group on Water Management), signed a Roadmap on water cooperation between Kazakhstan and Uzbekistan and agreed to jointly conduct a technical audit of the Sardoba reservoir with national and international experts.

[101] Based on the report of the mayor of Turkestan province at the Kazakh Senate's session on "Water security of Kazakhstan: current challenges and possibilities of their solution" (6 November) https://nomad.su/?a=3-202011090031

Prime-Ministers of Uzbekistan and Kazakhstan lay the foundation of a new neighborhood in Myrzakent village, Turkestan province in Kazakhstan, 10 May
Source: https://primeminister.kz

*Cooperation between Kazakhstan and Uzbekistan in elimination of consequences of the Sardoba dam collapse was highly apprized from international experts. As the Global Observatory for Water and Peace notes:*

> *"In spite of the COVID-19 crisis, and despite a history of water mismanagement and regional tensions in the Syr Darya river basin, both countries managed not only to cooperate over the immediate recovery, but also to strengthen good neighborly relations, taking further steps towards joint management of the shared basin. They thus effectively turned water from a potential source of conflict into an opportunity for cooperation and peace. A first important milestone was reached on July 2, 2020 with the signing of a joint roadmap for transboundary water management. The Sardoba dam disaster could become a watershed in reshaping the transboundary water dynamics in Central Asia, which are central to the COVID-19 response and recovery. Indeed, strengthened regional water cooperation could become a driver of sustainable socio-economic recovery in a profoundly changed world economy, fostering peace and security."*[102]

## Expert Opinion of Prof. V.A. Dukhovniy: Omissions and Lessons

The history of hydrotechnical construction in Uzbekistan is a continuous line of improvement of water development and management in the Amu Darya and Syr Darya basins.

The hydrotechnical construction in Uzbekistan has been always advanced both in the Soviet Union and all over the world – starting from Farkhad HPP put into operation in 1948 and almost parallel commissioning of the Bozsu cascade of small HPPs on the Chirchik River followed by construction of such large structures as Kattagurgan, Tuyabuguz, and Takhiatash hydroschemes, Pachkamar reservoir.

The Uzbek Ministry of Water Resources launched such unique large structures as the Tuyamuyun hydroscheme, with its 8 billion $m^3$ reservoir on the Amu Darya River, the Andizhan reservoir with a unique buttress dam, and, eventually, the Talimarjan reservoir with

[102] Global Observatory for Water and Peace. Strategic Foresight Discussion Note. Hydrodiplomacy in Rapid Action: Early Insights from the Sardoba Dam Disaster in Central Asia. 9 September 2020. Online: www.genevawaterhub.org/sites/default/files/atoms/files/central_asia_sardoba_dam_disaster_rapid_hydrodiplomacy_-_finalsept_2020.pdf

more than 1 billion $m^3$ hydraulic fill dam. All those structures have been operating successfully and reliably for a long time, without causing any concerns.

Thus, it is particularly bitter to see the accident that took place on the Sardoba reservoir on 1 May 2020 and caused huge economic damage to the whole Central branch of the South Golodnostepskiy Canal. The exemplary irrigation system built in the sixties virtually has been destroyed. The troubled waters have destroyed more than dozen kilometers of main and inter-farm canals and collecting drains that maintained irrigated land. Investigative authorities carried out the instructions of the President that all guilty persons should be held to accountable, and design and construction flaws were thoroughly investigated. It is also important to openly study engineering and water-management causes that led to the accident so that to learn lessons for the future.

Design and construction of the Sardoba reservoir represent a chain of ill-thought and insufficiently economically sound decisions.

1. Since the Toktogul hydroscheme had been converted to energy generation mode and water delivery in summer had decreased on average by 4.5 $km^3$, it became necessary to buy energy from Kyrgyzstan to ensure water releases or, at least, to compensate a portion of this undersupply of water through additional storage in river's middle reaches.

By the 1998 Agreement concluded between the riparian countries of the Syr Darya river basin, water and energy were delivered to Kazakhstan and Uzbekistan in summer, while in winter the downstream countries supplied energy to Kyrgyzstan and a small portion to Tajikistan.

In 2001, the Agreement stopped to be effective. Uzbekistan decided to build reservoirs to accumulate winter flow. Those plans included the Sardoba reservoir as well. From today's perspective, this decision was rather wrong in terms of comparative costs for construction of compensating reservoirs. However, that time this line of conduct was chosen to overcome flow-regulation pressure from the side of upstream countries.

2. The cost of water in the Sardoba reservoir is estimated at 45 cents per 1 $km^3$ (construction costs of $404.4 million per useful volume of 922 $Mm^3$).[103] By recalculating for electricity supplied simultaneously with water by the Naryn hydropower cascade, the cost of electricity at the current value will be 0.12 x 0.45 = 0.057 dollars per kWh, which is 40% more expensive than the price of electricity supplied to external consumers by "Kyrgyzenergo" (4 cents/1 $km^3$).

Certainly, it would have been necessary to negotiate annually the conditions of energy sale and water supply, but this would have saved Uzbekistan from unnecessary capital investments and the emergency situation. Moreover, construction of the Sardoba reservoir per se caused significant damage to irrigated agriculture in the Syrdarya province, because 6,500 ha of irrigated land were withdrawn and another 8,000 ha was submerged in the Mekhnatabad district. But no one, of course, could have assumed the scale of destruction and the cost of recovery after the accident.

3. Fairly, location of the reservoir at the tail of the Central branch of South Golodnostepskiy Canal was quite unfavorable, first, due to geological conditions. The reservoir is located in the periphery of alluvial cone of watercourses flowing from the Turkestan ridge and the alluvial sediments bed at different depths under modern sediments of steppe landscape at the boundary of Sardoba depression. Due to such complex geomorphology, there are interbedded gypsum-bearing soils in the site of the reservoir. Moreover, such soils have different degrees of solubility: from dense lime horizons to slowly dissolving gypsum "chimneys" that during the period of less than one year dissolve and create a good basis for intrusion of water. The same phenomena were observed during construction of a reservoir in an experimental farm of the Central Asian Irrigation Research Institute (SANIIRI) – the state farm "1a" named by G. Gulyam. However, in addition to gypsum, subsiding loess soil that nosed in this zone from neighboring farms posed a risk in the bed of reservoir dams. Therefore, a very detailed survey of soils in the basement was needed before location of the reservoir with the head of 30 m. But even in case of detailed study conducted in advance, no one could exclude a possibility of seepage under dam embankment or subsidence of the dam itself in such complex soils. Hence, this required drainage of a dam, a piezometrical network, laboratory monitoring of soil density, consolidation tests of the soil in the basement, and thorough monitoring by skilled operations staff. Besides, the burst on the left side of the dam, which was not the highest point of the dam – could occur if this site was in the subsiding basement and the status of the dam was not monitored regularly. But most probably this was due to seepage in the basement or failure to observe the required soil density in the dam embankment.

4. It is unclear why so many companies were involved in construction and operation? Why the national railway company took part in the construction, given that hydrotechnical and railway construction requirements are different? Finally, why operation of the reservoir was not developed by the Ministry of Water Management and again was transferred to the railroad company?

As we can see, there were many risk factors, which had to be taken into account by designers, expertise, builders and operators in the selected site. Hence, this leads to a conclusion that the national water sector requires serious capacity building efforts.

[103] Given the efforts for rehabilitation of the Sardoba dam and the possibly changed volume of the reservoir as a result of reconstruction, the cost will change