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Water & Oil

by GIANNI DI GIOVANNI

Readers – at least those who are less familiar with our industry – might be surprised to see that we have dedicated this entire issue of *Oil* (a magazine focusing on energy in general and on oil in particular) to the subject of "water."
Yet they would be mastaken, because energy generation, oil, and water resources are in fact intimately connected and mutually dependent. We need water to extract crude oil and gas, and this is a relationship that has been unchanged for no little time. As we shall see in this issue, water has been used for decades in "flushing" to increase the efficiency of oil and gas production, while biofuels consume water as they grow through photosynthesis. And – turning to more recent concerns – water has to be used in horizontal drilling and hydraulic fracturing when mining in rock formations.
In addition, water is key to the (still) undervalued hydropower industry. Above all, though, water and oil are constituent parts of the essential and delicate environmental balancing act, without which the future of humankind would likely be under threat.
Yet the availability of water seems to be less and less certain and, indeed, the outlook is extremely worrying. The rise in global population and in living standards in vast areas hitherto on the margins of development – and the requirements this brings in terms of industrial growth, consumption and energy demand – unfortunately mean that the situation could become very serious within a couple of decades, unless we make some changes: environmentally, economically, socially and in international relations. Besides, the alarm bells have already begun to sound. Even now, entire populations lack direct access to drinking water and desertification is on the rise, while in crucial areas for international stability there is severe tension – between India and China, or Ethiopia and Egypt, for example – over massive infrastructure projects to exploit water resources. It is well known, too, that Israeli control of the Golan Heights and the abundant water there is one of the core issues of the Middle East crisis. However, there is no shortage of positive examples that offer glimpses of new partnerships, like the sweeping agreement signed by China and Kazakhstan – whose historically frosty and formal relations have been transformed into new forms of cooperation on trade and resource sharing.
Some people say that water could be a cause of future wars – like oil was in the last century. Certainly, it is one of the most pressing issues humanity will face in this century.
However, this bleak outlook can be at least partly offset by the knowledge that we can deal with this crisis: we have water and it is fairly well distributed; now it is a matter of managing our resources in a more balanced way. The technologies exist, so now we must commit to their development and dissemination. At long last, we are seeing a rapid shift in government and industry attitudes in this area and, as we report, one significant example is the strategy adopted by Coca-Cola, which is making a worldwide effort to save the water that is quite obviously an essential part of its business.
The water question is, then, an incredibly complex one, which in the coming decades will play a crucial role in the success or failure of sectors that are essential for the future of humankind – not least energy. The boundaries of the playing field are constantly shifting and we cannot ignore the possibility of new oil producers joining the fray. Cyprus, for example, is readying itself to become an exporter country, thanks to discoveries in the Levantine Basin. In addition, as Cypriot Minister of Energy, Yiorgos Lakkotrypis told us, Cyprus hopes that the new mining activities in the eastern Mediterranean – between Israel, Lebanon and Egypt – will "bring the necessary stability to the region – an issue that is quite pressing these days with the Syrian crisis." This telling remark once again puts energy at the heart of opportunities for peace in many parts of the world and is thus a comment that *Oil* could not ignore.

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edited by Eni's Planning and Control Department

A new challenge

LORD PETER MANDELSON is a former European Trade Commissioner and British First Secretary of State. As Trade Commissioner between 2004 and 2008, he negotiated trade agreements with many countries and led European negotiations in the WTO Doha World Trade Round. Prior to this, he was Minister without Portfolio, Secretary of State for Trade and Industry, Northern Ireland Secretary and Secretary of State for Business, Innovation and Skills in the British government under Tony Blair and Gordon Brown between 1997 and 2010.

We are living in an era of unprecedented growth in demand for the planet's resources as the global population grows and living standards rise. By 2050 the world's population is likely to reach 9.6 billion people, up from today's 7 billion, and rapidly rising economic prosperity across Asia, Latin America and Africa will see resource consumption levels approach those in developed economies. The result will be that access to resources, tensions between the resource "rich" and the resource "poor" and how productively we use resources – resource risks – will be some of the most pressing issues of this century.

Predominant among these risks is water. Securing sufficient water supplies is a challenge in itself, but water is also a key factor in some of the other big global resource challenges, particularly the production of food and energy. Indeed, this is the first and most fundamental risk: the failure to see that water can only be properly understood as a systemic feature of all global resource challenges. Water has often been seen as a local, low-income issue. The risks – to supply and demand – are increasingly going to play out in, and between, middle and high-income countries. Water as a global prosperity and security issue is a new dynamic for governments, consumers, and businesses alike.

At the most basic level, "water risk" is the failure to secure the water that the world needs to drink, cook and wash. Estimates put this at 25–50 liters per person per day, around 1.5 percent–3 percent of total global water withdrawals for human use. As such, the problem is not so much the quantity, but the distribution and quality of water. These risks are amply demonstrated in China, where the available water resource per person per year is less than a third of the global average – in some regions it is only one twelfth – and pollution means that less than half of China's water can now be treated to make it safe for drinking.

Water can also be a limiting factor in food production. It is estimated that 90 percent of the world's fresh-water consumption is in irrigation. Today, less than 20 percent of the world's cultivated area is irrigated and, as food demand is predicted to grow by 50 percent by 2030 and by 70 percent by 2050, demand for irrigation will increase enormously. This is being accompanied by rising demand for water-intensive meat products. As a result groundwater resources will come under increasing strain, often aquifers which are being replenished unsustainably slowly or not at all.

Water risk is also a key factor in satisfying the world's growing demand for energy; directly, through hydroelectric power – which, for instance, supplies three quarters of Brazil's electricity and 16 percent of the world's total. But water is also critical for cooling thermoelectric power plants. As much as half of the U.S.' water withdrawals are used in power generation for this purpose. Shale, tight and other unconventional sources of oil and gas that are transforming global energy supplies depend on the use of water in large quantities. The U.S. experience last year showed that drought can quickly lead to power plants being shut down and shale gas extraction being restricted.

This food-energy-water nexus is increasingly recognized beyond academic circles and among policymakers. However, less well understood are second-order water risks – the implications of efforts to secure reliable and affordable access to water.

Most obvious is the risk of conflict over scarce water resources. Ethiopia's Grand Renaissance Dam on the Blue Nile led Egypt's former Minister of Water to warn that "Egypt reserves the right to take whatever course it sees suitable" to defend its downstream interests. Declining flows in the Indus River basin have exacerbated tensions between nuclear giants India and Pakistan, and spawned the phrase "water terrorism." Across the globe, downstream nations will be looking at their upstream neighbors with increasing concern.

We will need recognition of the magnitude of water risk, long-term vision and leadership

Global climate change and shifting patterns of water distribution will also become a driver of global migration. This will put pressure on housing, health and welfare provisions in areas of plentiful water supply. It will act as a drain on arid regions as those who can afford to leave take their wealth and skills with them.

Growing demands on water will also see an increase in virtual water trade flows – trade in goods in which water is "embedded" in production, such as food and energy. This will place economic burdens on arid areas with growing import bills and widening current account deficits. It also raises the prospect of the commodification and "financialization" of water, an issue that abounds with economic and ethical questions. Perhaps one day we will even see water being traded across the financial markets of the world and subject to the swings and shocks of commodity markets.

Tackling these many and widespread risks will require technological innovation, effective policy responses and coordination across international borders. Multilateral attempts to address climate change are faltering, but no country in the world can afford to ignore their water risks. This is some cause for hope. For those up to the task, water's risks will be opportunities, driving down the cost of technologies such as water desalination, cutting costs through water-efficiency, and building global champions to forge new solutions. To get there we will need recognition of the magnitude of water risk, long-term vision and leadership.

Exclusive/Talking with Yiorgos Lakkotrypis, Cypriot Minister of Energy

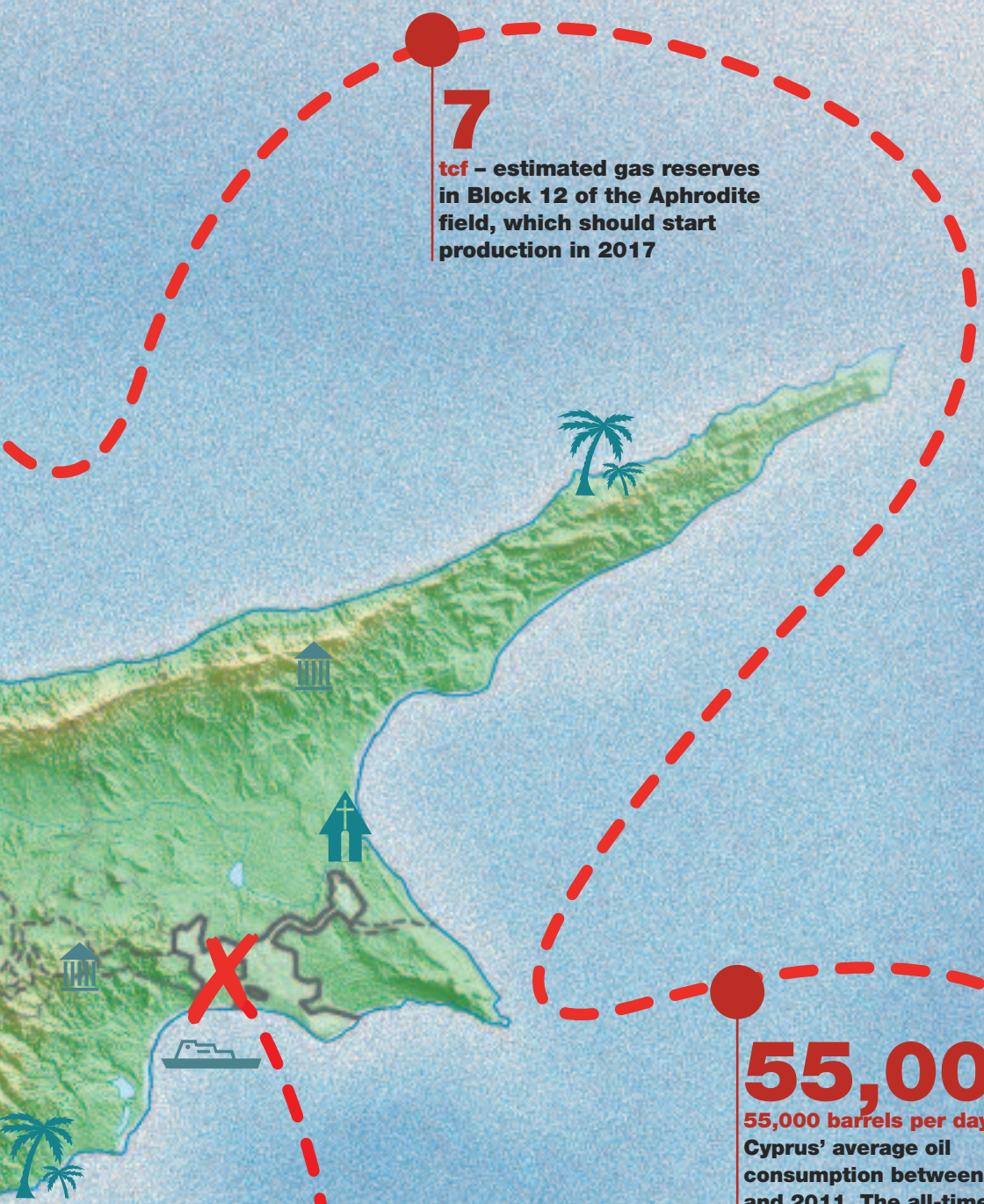
Treasure Island

3
tcf – estimated gas reserves in the Aphrodite-2 field at the Cyprus-Israel offshore border

28-41
bcf – volume of gas to be imported annually by Cyprus until Aphrodite starts production

2015
the year that construction is expected to begin on a new liquefied natural gas (LNG) terminal in Vasilikos, which should be operational in 2019

New reserves of offshore gas discovered in the Levantine basin will enable Cyprus to become an exporter and allow the E.U. to reduce its dependence on Russia. The only obstacle could be Turkey



7

tcf – estimated gas reserves in Block 12 of the Aphrodite field, which should start production in 2017

55,000

55,000 barrels per day (bpd) – Cyprus' average oil consumption between 2000 and 2011. The all-time high of 60,000 bpd was recorded in 2008

5

million tons of LNG per year will be produced by the three liquefaction trains to be built in the new terminal

Source: U.S. Energy Information Administration (EIA)

YIORGOS LAKKOTRYPIS
is Minister of Energy, Commerce, Industry and Tourism of Cyprus. In 2008 he was appointed by the Council of Ministers as a member of the Board of Directors of the Cyprus Investment Promotion Agency (CIPA), a position he held until November 2011. In 2009 he was also appointed as a member of the Board of Directors of the Natural Gas Public Company (DEFA), a position he held until his appointment as Minister of Commerce.

About 7 trillion cubic feet of new gas reserves have been discovered off the coast of Cyprus – a treasure that could change the balance of the whole area and will definitely change the island's future. This was the message from Cypriot Minister of Commerce, Industry and Tourism, Yiorgos Lakkotrypis,who was interviewed by *Oil* during a recent official visit to Washington, D.C. Cyprus intends to use the gas to meet domestic demand – largely in place of oil – before quickly becoming an exporter country.

by MOLLY MOORE

It has been an especially significant day for your country, which is in the early stages of evaluating a new fossil fuel reserve discovered off the coast of Cyprus.

Yes, today we started production testing of the Aphrodite Field in Block 12. This is the first time we have done gas flaring; the first time that Cypriot natural gas surfaced from the seabed. It is a very symbolic event, even beyond the technical requirements of running the actual test.

How important is the discovery of gas and possibly oil reserves in Block 12 off the coast of Cyprus to your country?

It's important in many, many different ways. First of all, it is a great prospect for the country to develop a new industry – an oil and gas industry – and hopefully over the next few years become an exporter of natural gas.

This has both economic and political implications. On the economic side, everybody understands the consequences and implications. On the political side, we hope the discovery – not only in the Cyprus Exclusive Economic Zone, but on the Israeli side, Lebanon and Egypt – will bring the necessary sta-

bility to the region, something which is quite vivid these days with the Syrian crisis. We hope these discoveries will bring the necessary political and economic development to the entire region.

What are the challenges Cyprus will face in dealing with those neighbors as this industry expands?

There are a lot of technical challenges we have to overcome. Yes, we have discoveries; now we have to proceed to the exploitation stages we have set out for ourselves, for these discoveries and for future ones. We not only have Noble Energy operating in Block 12, we have Italy's Eni operating in three more blocks in a joint venture with Korea's Kogas, and France's Total operating in two more blocks. Technically speaking, there are a number of challenges we need to overcome to move to exploitation and monetization as soon as possible. On the political angle, we have great relationships with the three of our neighbors who share the Exclusive Economic Zone with us – Israel, Lebanon and Egypt. We already have signed delimitation agreements will all three of them. These countries all around respect this agreement. The one challenge for Cyprus could be Turkey. We have a longstanding issue, of 39 years, created by the Turkish invasion of 1974. We truly hope this new discovery will bring Turkey to terms and eventually show the political will to resolve the Cyprus problem. But let me also be clear: We are moving ahead with our exploration and exploitation plans regardless, because we will not be held hostage for another 39 years.

What are you finding in the other blocks where Eni and Total are exploring?

The prospects appear quite significant, but it's too early to say because Eni and Total just started their seismic surveys in these blocks. They have quite an aggressive plan for exploration, which will start in 2014 and will last for at least 12 months. We are seeing both companies in all five blocks moving very aggressively with their plans, and Total is also prospecting for oil as well as natural gas.

What are the prospects for oil?

We haven't had any official discoveries yet. There are discussions of potential discoveries in Israel and now we have Total looking for it. The implications could be significant. If you discover oil, chances are the entire system has an oil structure.

How do you see these fuel discoveries in the eastern Mediterranean changing the European energy picture?

In May there was a presentation by the President of the European Commission, José Manuel Barroso. In that presentation, for the first time, he showed a new potential source of gas for the European Union, which was the eastern corridor. We all know the European Union is trying to lessen its dependency on Russian gas. These eastern Mediterranean reserves could help the European Union achieve its goal and diversify its energy sources.

What does this do to Cyprus' relationship with Russia?

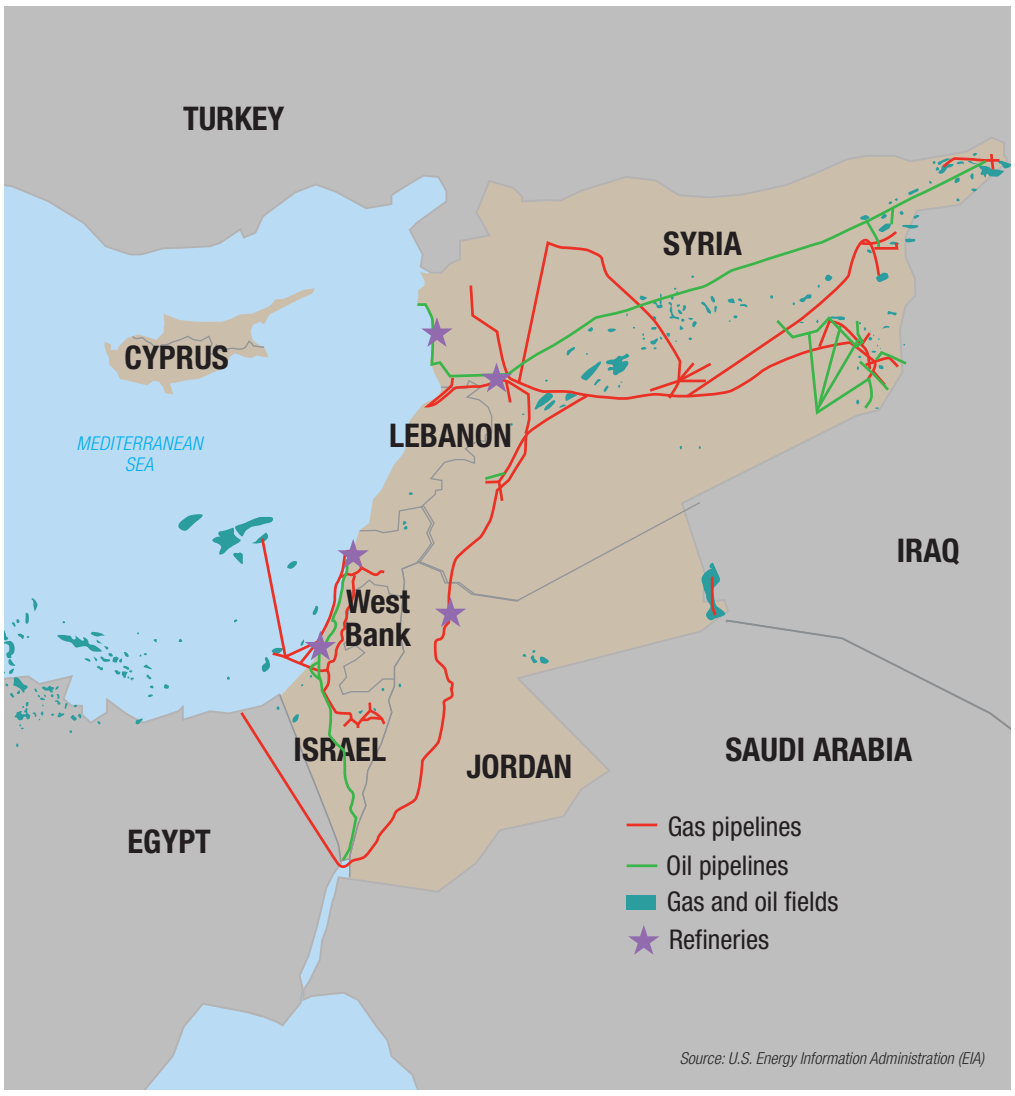
At the end of the day Cyprus maintains great relationships with Russia on many common fronts – professional services, tourism, cultural, economic, political. As a country, we have to go ahead with our exploration plans.

While these discoveries are very important for Cyprus, what is Cyprus doing beyond fossil fuels in terms of looking at renewable energy sources and greater water sustainability?

Part of my discussions with the U.S. Secretary of Energy Ernest Moniz have been about how the U.S. can help us with the knowledge and technology so that renewables – especially solar energy – can be introduced into our energy mix as soon as possible. We very recently signed a trilateral agreement among Cyprus, Israel and Greece about energy and water resources and how to best manage them in a sustainable way. We view renewable energy as an immediate measure we can take to reduce the cost of electricity in Cyprus. We have an isolated system, we are not connected to any energy grid, and the prices of electricity are the highest in Europe. So, if we're able to quickly introduce renewables, especially solar, into our grid, this will help us achieve our goal to reduce electricity prices and relieve households of expensive bills, and also help the economy.

Regardless of the offshore activities for oil and gas, determining →

> There were a lot of bids for the remaining blocks, which we have not allocated. We closed the second round of bidding mainly because we want to develop our resources in a sustainable manner, which will leave enough for future generations



A STRATEGIC POSITION

Recent explorations in the Levantine basin have revealed 2.5 billion barrels of proven oil reserves – 99.5 percent of them in Syria – and 18.2 trillion cubic feet of proven reserves of gas. Thanks to its geographical position, Cyprus aims to become a Mediterranean energy hub.

how we can introduce renewables into the energy mix as soon as possible is very high on our agenda.

What are the best projections of the size of your gas reserves?

Right now what we have is based on the discovery announced in 2011 which was 5-8 trillion cubic feet. We do expect preliminary results to be announced toward the end of September or beginning of October based on appraisal data we have gotten. The appraisal started in early June and is coming to its final stages. We just need to interpret the data, which is an ongoing process anyway.

What is your timeline for drilling and production?

First we need to determine if the Aphrodite Field requires an additional appraisal. If the results are conclusive, then great. If the results are not conclusive, we might need another appraisal. If it is needed, it would happen early next year. Noble is going after other prospects in Block 12 besides the Aphrodite Field, and we think potentially we will have exploration drilling at the end of 2014. The same applies for Eni – they have plans for exploration drilling in 2014 – while Total is looking at drilling at the beginning of 2015.

Is there an assessment of the size of the reserves in other blocks?

It's too early; the seismic data research has just started. They will continue for the next three months, then we will be interpreting the data for a period of 6-8 weeks. After that we will have the exploration starting. We do have some seismic data, and these blocks appear to be quite good prospects. But we don't have anything to say concretely, "Look we have a new discovery here."

Do you have other requests pending for new licenses or agreements?

There were a lot of bids for the remaining blocks which we have not allocated. We closed the second round of bidding mostly because we want to develop our resources in a sustainable way, meaning we have to leave some for future generations. Not everything is to be developed immediately. But at the same time we do have open requests from Eni for two more blocks – five and six – where the political decision is still pending as to whether we will allocate them. The primary question is whether we want to allocate two more blocks right now or whether we should wait for future generations. Once gas or oil is out, it's out. It's a question of when you want to develop this.

How much gas do you expect to extract annually?

We are currently looking at building a liquefied natural gas onshore facility, starting with either 3.5 million tons per annum or 5 million tons per annum. This plan is going to be expandable to accommodate future discoveries – not only Cypriot discoveries but neighboring-country production. Israel is right now trying to decide what its export strategy will be. We feel collaborating on the export strategy we will create tremendous economies of scale that would make our gas available at very competitive prices to the rest of the world.

Never having built an LNG facility before, how is Cyprus going about developing this project?

We have signed a memorandum of understanding with the energy companies Noble and Delek about negotiating the terms of a joint project that we are developing right now. This is brand new to us. The whole oil and gas industry is new to Cyprus. We have very reputable consultants, including some from the U.S., who are advising us on the legal / commercial aspects of the agreement. We will go out to find project financing, at which point we will also seek advice. Throughout the whole process we are seeking and getting specialized advice for what we need. We know we are doing not only what we need for the best interests of the country, but are also creating the necessary know-how within the country.

How much of your gas extraction do you expect to use for domestic consumption and how much will be for export?

Our domestic consumption is comparatively low because of the small size of the country and the economic circumstances we are undergoing, which is further decreasing the demand for electricity and fuel. Cyprus could be needing anywhere from .55 to .7 bcm [billion cubic meters] over the next few years. By comparison, 1 trillion cubic feet of gas can power Cyprus for 25 years. If you discover 4, 5, 6 trillion cubic feet, that means you have a whole lot of gas you can export.

Who do you see as being your greatest export markets?

The export potentials are something we are monitoring carefully. Right now as things stand, it looks like Asia. There is price premium in Asia for long- term contracts. But it could also be Europe. We're monitoring carefully what happen with the new LNG plants coming online in Australia, or in the U.S. with shale gas, which is potentially the biggest question mark. How much U.S. gas will hit the LNG market in the next 5, 6, 10 years? We are monitoring also the increase in demand to see whether the supply will outstrip the demand or vice versa. But as we speak right now, the most lucrative markets appear to be Asia and Europe.

You mentioned Asia first over Europe.

Because of the price premium and because of the geographical proximity of Cyprus, something which makes the case for a LNG terminal very compelling. We are talking about the southernmost border of the European Union closest to the Suez Canal, making export possibilities to the Far East very appealing. But also the distance to Europe makes that export possibility very appealing as well.

What about the possibility of selling to Turkey?

As things stand today, with the Cypriot problem still open, there is no discussion going on. There cannot be a discussion. Turkey claims that Cyprus doesn't exist, so how can you negotiate with somebody who says you are not there? We do hope this discovery in the Eastern Med will create new momentum – will hopefully eventually give Turkey the political will to resolve the problem.

What is Cyprus doing to safeguard the revenues you're going to get and how will it determine how the profits will be spent?

We've looked at a number of modes. The one that looks very appealing to us is the Norwegian model of a sovereign wealth fund, which has been established inside Cyprus by the minister of finance. The sovereign wealth fund is going to handle the revenues from hydrocarbon resources. The thinking right now is that it would hold them in three different categories: one to help finance the infrastructure that we need, the second helping us reduce our debt, and the third to save a big portion for future generations. We are looking at how the Norwegians manage their fund; it's one of the largest investment funds in the world right now. We want to do that in a very transparent and sustainable way.

How do you think this discovery is changing Cyprus in the eyes of Cypriots?

Cypriots are really looking at this as being a great prospect and a great hope. We understand the weight and the responsibility, the duty and the demand of the people to manage this responsibly. Cypriots look at it in two different ways: economic, and also political. They are seeing it in economic terms of boosting the economy in the mid term and long term, but also in political terms. It would be a game-changer as to becoming a net exporter of hydrocarbons and fossil fuels. It gives you a leverage incomparable to your size, which is small. We hope that by managing this wealth responsibly we'll be able to have economic benefits, but also much more political leverage than we had in the past.

As you go around the world, are people looking at Cyprus differently?

They're looking at us with great interest about what is going on. Certainly, the U.S. has a lot of interest in what is going on the region, and the E.U. the same. One of the primary goals of our trip to the U.S. was to inform stakeholders, think tanks, government officials and journalists of what is going in the East Med and the prospects that are being created.

When you talk to your counterparts in the U.S. government, what is their greatest concern?

To be frank, I was really pleased to see how well informed government officials are about the activities. It comes without saying that their primary goal is to ensure U.S. interests in the region are present through Nobel Energy, through consultation, through other technical support Mr. Moniz was very kind to offer to us.

What is the reaction you're getting from your creditors in dealing with the current economic crisis?

To be honest, when the whole thing broke out, all we had were prospects, we had no proven reserves. As we move to proven reserves and monetization, the primary concern of our creditors is that we manage this responsibly. Responsibly in the sense that we don't go around wasting money on large infrastructure projects such as an energy terminal if it doesn't make sense. Or how are we are going to manage the revenues that come from the hydrocarbon exploitation. That's their primary concern. Certainly from the discussions we've been having with the EC, IMF and Central Bank about what we've done since the first assessment, they were pretty pleased.

What are you doing in terms of safety and environmental protections relating to exploration and drilling, for preventing problems such as the BP blowout in the Gulf of Mexico?

Those are exactly the things we discussed with the State Department and my counterpart, Mr. Moniz. Unfortunately the U.S. has great experience with this. We agreed we will seek further cooperation and assistance from the U.S. to be able to lay out detailed plans in the unlikely event of such a disaster happening in the East Med. This is something that doesn't interest only Cyprus, it also interests the other countries like Israel, Lebanon and Egypt that are operating in deepwater drilling.

You've been in office for six months during an amazing period for an energy minister in Cyprus. What kind of pressure has this brought to bear on you personally?

It's been six months. I haven't slept well. The pressure stems from the need that we manage all this very responsibly. Not only these discoveries, but future discoveries. How do you monetize? What's your relationship with the other countries? With the companies? It's a multi-dimensional puzzle. The big issues for us are to put the right structures in place, to find the right people who will help drive these through. This is all brand new. I have been seeking assistance not only from consultants but from ex-pat Cypriots who have been working in oil and gas majors. They have the knowledge. We need to attract them back to help us manage. Certainly the management comes in multiple layers – political, technocratic, administrative, national oil companies, other ministries that are involved in environment and safety, foreign affairs – it's just an endless list of things that must happen. It's the pressure to manage all this responsibly.

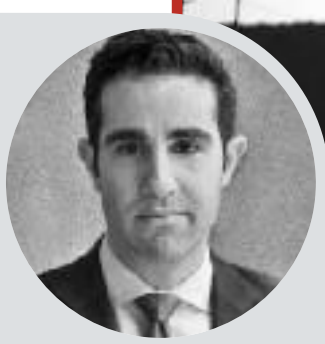
NICOSIA, AUG. 8, 2013
The energy ministers of Greece and Cyprus, Yannis Maniatis and Yiorgos Lakkotrypis (from left to right) and their Israeli counterpart Silvan Shalom signed a memorandum of understanding in which they committed themselves to cooperating in the fields of energy and water.

Molly Moore is a senior vice president of Sanderson Strategies Group, a Washington, D.C., media strategies firm, and a former *Washington Post* foreign correspondent.

A different view/Michael Levi of the Council on Foreign Relations

Energy independence is not on the cards

The United States is going to remain exposed to the economic consequences of oil market disruptions around the world. Increased U.S. oil production is unlikely to lower world oil prices – the big producers cannot afford that



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is David M. Rubenstein Senior Fellow for Energy and the Environment and Director of the Program on Energy Security and Climate Change of the Council on Foreign Relations (CFR). He has written books on the future of American energy and on China's natural resource quest (see p. 61). Levi is the author of studies and books on climate diplomacy, energy innovation, nuclear terrorism and proliferation, arms control, and science and technology in the Islamic world.

by SERENA VAN DYNE

The United States has witnessed a boom in oil and gas production in recent years, but the chances of the superpower becoming energy independent are "very slim"; in fact, the U.S. "will remain exposed to the economic consequences of oil market disruptions around the world." This somewhat contrarian view comes from Michael Levi, Director of the Program on Energy Security and Climate Change at the Council on Foreign Relations. According to Levi, it is also unlikely that an increase in U.S. oil production will result in a marked fall in world prices over the long term. Major producer-countries – especially Saudi Arabia – cannot allow that to happen. In order to make the most of the opportunities presented by this energy revolution, the U.S. will have to bring in new rules on hydrocarbons, create larger markets for emerging technologies and adapt its foreign policy to the new developments.

In recent years, the U.S. has undergone an energy revolution on various fronts, from gas to oil to renewables. What scenarios are opening up for the country?

You're exactly right to ask for scenarios rather than predictions. The United States has recently seen big changes on a wide range of different fronts. Oil production has been up for four years in a row after decades of near-ceaseless decline. Natural gas has surpassed coal as the country's top source of energy. Renewable electricity production has doubled and prices have dropped sharply. And U.S. oil consumption has fallen almost every year since 2005. All of these trends can be extended – but all of them depend, in one way or another, on a mix of policy decisions, technology developments, and broader market conditions. For example, the United States could choose to encourage greater use of natural gas in power generation and vehicles, or various U.S. states could severely curtail shale gas production. The U.S. government could take advantage of new car and truck technologies by implementing more stringent fuel economy standards, or it could decide to relax today's rules in the face of rising oil production. Ultimately the decisions we make will determine the outcome of the various changes that have swept through the American energy sector in recent years.

Is there not a risk that this sharp rise in the production of both conventional and unconventional hydrocarbons could compromise the development of clean energy?

There is – but I think people are focusing on the wrong aspect. U.S. oil production is unlikely to sharply lower world oil prices in the long run – the big strategic producers, notably Saudi Arabia, cannot afford that. So long as oil prices are relatively high, economic incentives remain to adopt more efficient cars and trucks. When it comes to clean energy – whether renewables or nuclear – natural gas appears to be having a limited impact; technological development and policy changes have been far more important. (Natural gas has done

far more to push aside coal than to displace clean energy.) Where I worry that progress could be compromised is in policymaking. If the United States backs off on efforts to promote clean energy or reduce oil use because of the hydrocarbon boom, then yes, that will hurt progress. But that's not an inevitable development – it depends on the decisions we make.

What should the U.S. government do to make the most of the opportunities offered by this energy boom?

I would emphasize three things. First, get the rules right for oil and gas development. Obviously rules that are unreasonably strict could endanger the industry and its dividends. But rules that are too weak are dangerous too. There is still a lot of skepticism in much of the country about oil and gas development.

Having good rules in place makes it more likely that people will let development proceed. Second, create bigger markets for the emerging technologies. Penalize greenhouse gas emissions – that will increase the market for natural gas and for renewable energy. Penalize excessive oil consumption – that will grow the market for efficient vehicles and for alternatives to oil. The third thing the U.S. government should do is align its foreign policy with the new developments. For example, use the growth in U.S. supplies to reinforce free trade, rather than moving to restrict it, or use falling U.S. emissions to reinvigorate U.S. efforts to promote international progress on climate change.

Despite the fact that many refineries have closed, America's refining capacity continues to grow. How do you explain that apparent contradiction?

The United States has a technological edge in refining right now. It also has convenient and affordable feedstock. But it has a declining domestic market at the same time – in fact, some advanced refineries expanded when their owners weren't expecting falling domestic demand, and have now lowered their capital costs. These are all reasons why exports are increasing. I don't see a contradiction here – there are lots of products where we have expanding domestic production and falling domestic consumption at the same time. The United States is already a net exporter.

What are the current and future effects of the U.S. energy revolution on the world hydrocarbon market and on global geopolitical balances?

We're already seeing big consequences in natural gas. The United States was slated to become a big LNG importer, with all the geopolitical consequences that entails, but it is now looking at exporting instead. Europeans are seeing more options for natural gas supplies as a result – not from the United States directly, but from other producers who were intending to sell into the U.S. market. That's given them more leverage in negotiations with Russia, so we're seeing a trend toward more market-based natural gas pricing, which means less leverage for Russia. I expect to see this trend continue in the coming years.

Oil is more complicated. The surprising growth of U.S. production in 2012 allowed countries to impose tough sanctions on Iran without sending the price of oil soaring. But that was probably a one-time occurrence. Increasing production is now expected. The United States is going to remain exposed to the economic consequences of oil market disruptions around the world, so "energy independence" is not on the cards. To me the biggest unknown is how key countries will react to the changes in the United States. Will China try to take a stronger role in securing sea-lanes? Will Middle Eastern oil producers lose confidence in their security relationships with the United States?

Those sorts of developments are impossible to predict, but could have much broader consequences.

Meanwhile, there are increasing concerns in the U.S. – and across the world – about the scarcity of water. The global nexus between energy and water introduces cross-sectoral vulnerabilities whereby water problems can become energy problems and vice versa. How is the U.S. administration addressing this challenge and what strategies are needed?

The link between water and unconventional oil and gas is generally handled at the state level, not the federal level, in the United States. Each state is handling it differently. You're seeing increasingly strict regulations on the disposal of wastewater from production processes. And I think you're going to see steadily more stringent regulations on well casings in an effort to protect groundwater. The other big question for states is water allocation: even if you are not worried about pollution you need to figure out how to distribute water that's often locally scarce. The big question for Washington right now is how much the federal government should get involved. A lot of the most important water issues vary so much from community to community that there's no useful way for the federal government to regulate. But there are some matters – in particular, requiring disclosure of fracking chemicals, in order to reassure communities – where the federal government can play an important role.

> Oil production has been up for four years in a row after decades of near-ceaseless decline. Natural gas has surpassed coal as the country's top source of energy. Renewable electricity production has doubled and prices have dropped sharply

Warning/By 2025, two-thirds of the world's population could be living under water-stressed conditions

A gathering global storm

Seen wrongly as an infinite resource, water now struggles to keep up with constant population growth and intensive use in agriculture and new mining techniques. Multinationals, meanwhile, are committing to programs designed to ward off future crises

by PAUL BETTS

The idea that the world risks facing a major water crisis with unpredictable and critical consequences would have been regarded as far-fetched, to say the least, 50 years or so ago. The general perception was that water was an infinite resource. But then the world population was less than half that of today; the inhabitants of industrialized, developed and developing regions were not as affluent as they are now, eating less meat and consuming fewer calories, so less water was needed to produce food; rapid urbanization and the development of mass transport and affordable cars led to an explosion in the demand for energy and electricity, an industrial sector that is one of the biggest consumers of water.

CAREFUL MANAGEMENT

Yet even 50 years ago, dark threatening storm clouds were already appearing on the horizon. First and foremost, according to most economists and social scientists, the steady rise in the world population – especially in the poorest and less developed regions of the world – and an even faster rise in water consumption as a result of the competition for water from agriculture, industry, urbanization, electricity generation and biofuel crops (to list just a few of the competing contenders for water) has been putting increasing pressure on water resources. And this is before taking into account the eventual impact of climate change on water supplies caused by receding glaciers, reduced stream and river flows, and acute droughts in various regions of both the developed and less developed world. All in all, rather than being an infinite resource, water is increasingly becoming a diminishing resource. A United Nations report entitled "Living in a changing world" – written after the U.N. members established the Millennium Development Goals 13 years ago – points out that "There is enough water for everyone. The problem we face today is largely one of governance: equitably sharing this water while ensuring the sustainability of natural ecosystems. At this point in time, we have not yet achieved this balance."

U.N. There is enough water for everyone. The problem we face today is largely one of governance: equitably sharing this water while ensuring the sustainability of natural ecosystems. At this point in time, we have not yet achieved this balance.

FAO. If we want to avoid future food crisis, we need more investments to achieve productivity gains in agriculture in developing countries using existing and new technologies. Political will is needed to create the enabling environment for increasing water productivity.

SEEKING A BALANCE

Achieving this balance is proving difficult and becoming all the more urgent. Water scarcity has shot to the top of the agenda and preoccupations of governments, policy makers, industrialists, environmentalists, economists and scientists, along with closely related and interrelated issues such as hunger, poverty, health and sanitation, food production, power generation, and climate change. Indeed, the U.N. now warns that by 2025, 1.8 billion people will live in regions with severe water scarcity and two-thirds of the world's population could be living under water-stressed conditions – in other words finding it difficult to obtain fresh water because of depleting resources. According to the U.N.'s Unctad agency, global food demand is expected to increase by as much as 70 per cent by 2050 as the world population rises from over 6.8 billion to 9 billion and diets continue to change as a result of socio-economic improvements – particularly in OECD and BRIC countries. The World Bank estimates that 1.4 billion people live in extreme poverty – that is, living on less than $1.25 a day – and most, if not all, suffer from acute fresh-water shortages. The World Bank also warns that climate change risks altering profoundly future patterns of both water availability and use, severely increasing the levels of water stress and insecurity both at the global scale and in sectors that depend on water.

ELECTRICITY UNDER THREAT

Take electricity, for example. A recent study by the Austrian-based Institute for International Applied Systems Analysis, which looked at how higher water temperatures and reduced river flows could affect hydropower plants as well as nuclear and fossil fuel plants that draw water for cooling, found that many European countries could see a decrease in electricity generating capacity and an increase in electricity prices as a result of climate change. The problem is also global. Another study released at the beginning of this year by the International Energy Agency concluded that annual water consumption for global energy production was likely to double by 2035 – from 66 billion cubic meters today to 135 billion.

> The Gulf region could become a "blue technology" center of excellence and a significant international actor in the campaign to tackle the global issue of water scarcity

WATER AND FOOD

If power generation is a big user of water, agriculture is by far the biggest, accounting for some 70 per cent of all water withdrawals compared with 20 per cent in the case of industry and 10 per cent for domestic consumption. FAO, the Food and Agriculture Organization of the UN, says that while the daily drinking water needs of humans are very small – four liters per person – the water required to produce a person's daily food is much higher, varying between 2,000 and 5,000 liters. For years now, FAO has warned that while there has so far been no global water crisis, the serious water and food security problems in some developing countries and regions need to be urgently addressed. The agency says "if we want to avoid future food crisis, we need more investments to achieve productivity gains in agriculture in developing countries using existing and new technologies. Political will is needed to create the enabling environment for increasing water productivity." All the more so as FAO predicts that one in five developing countries will face water shortages by 2030, with the Near East, North Africa and parts of Asia all subject to water scarcity and stress.

The World Bank notes in a recent study that progress has been achieved in improving agricultural productivity, which has been steadily rising over the past 40 years. Irrigated agriculture, it adds, could be considered as a success story, given that in the second half of the 20th century food production more than doubled, thanks in part to innovation and technology. But it also warns that "we have enough water only if we act now to improve how water is used, particularly in agriculture, which is the main user." The problem is that reaching a consensus on how best to achieve water efficiency has so far proved impossible on the political level. For example, governments and policy makers are now divided over the mass production of crops for biofuels. Indeed, as more and more countries seek biofuels as part of their new energy mix, questions have increasingly been raised over whether the consumption of water needed to grow these crops make them a viable alternative.

THE ADVENT OF FRACKING

This also brings us to the current heated debate over whether fracking – the process of extracting shale oil and gas by hydraulic fracturing of rock with high pressure liquid – is a safe energy option in the long run, or a hazard to the environment with the risk of contaminating precious water tables. Many governments, especially the United Kingdom, now want to emulate the U.S., which has witnessed a significant shale gas boom with a boost to tax revenues, jobs, and a reduction in energy imports and household fuels. The economic arguments in favor of fracking appear overwhelming. But equally overwhelming has been the popular reaction against fracking in the U.K. as well as other countries considering this controversial process of oil and gas extraction. Although the U.K. government has encouraged industry to go ahead and start a major drilling campaign by offering what George Osborne, the chancellor of the exchequer, calls "the most generous tax regime in the world for shale," public protests seemed to have gained the upper hand so far. Cuadrilla Resources, the British shale gas company chaired by the former BP chief executive John Browne, has recently suspended drilling activities at its site in Balcombe, a village south of London that has become the focus of protests against the government's efforts to develop a shale gas and oil industry.

WORLD BANK. 1.4 billion people live in extreme poverty – that is, living on less than $1.25 a day – and most if not all suffer from acute freshwater shortages. We have enough water only if we act now to improve how water is used, particularly in agriculture, which is the main user.

UNILEVER. You focus on the right things, you put the consumer in the middle of all you do, and ultimately your shareholder will benefit as well – as a result but not as an objective in itself. And hopefully we will bring the world back a little bit of sanity.

"BLUE TECHNOLOGY" FOR THE MIDDLE EAST

Russia, China, Argentina, and Australia, along with the U.K., all see a bright energy future through shale exploitation. If ultimately, as most expect, the economic arguments for fracking prevail – especially if new technology developments can ease the concerns of environmentalists over water contamination – the shale revolution risks also having a serious impact on the current masters of the oil universe in the Middle East, with demand for Saudi Arabian, Iranian and U.A.E. crude declining. Yet even for these countries there could be a silver lining and one which would be highly beneficial for global efforts to preserve diminishing water resources. For the Middle East could well become an emerging water technology laboratory. These oil-rich countries have the money and the interest in developing new water technologies other than energy-hungry desalination plants. The Gulf region in particular could become a "blue technology" center of excellence not only to provide the necessary water for its growing population but also to become a significant international actor in the campaign to tackle the global issue of water scarcity by spearheading and funding the necessary research and development.

For water is now not only a major geopolitical issue, but it is also a huge business and a human rights issue. More and more companies are placing a strong emphasis on water management both in-house and in their supply chains. This issue now features prominently on many corporate social responsibility and sustainability agendas as the soaring thirst for water confronts rich and poor countries alike.

MULTINATIONALS TAKING A STAND

For many large multinational companies, it offers not only a philanthropic opportunity but also a good business one. Take the issue of sanitation, for example. There are currently 2.5 billion people in the world who lack access to clean water not only for drinking but for basic sanitary purposes, and there are 1 billion who go to bed hungry every night.

> Many European countries could see a decrease in electricity generating capacity and an increase in electricity prices as a result of climate change

Without urgent and concrete steps to improve this state of affairs the situation will inevitably become even more drastic as the world population continues to rise. This has persuaded the Gates Foundation to sponsor an important program to tackle this problem of basic sanitation – not simply to raise living and health conditions for the world's hungriest and poorest but also because of the economic benefits this produces. Indeed, Unicef has calculated that for every $1 spent on sanitation, the end result is $5.50 in economic productivity.

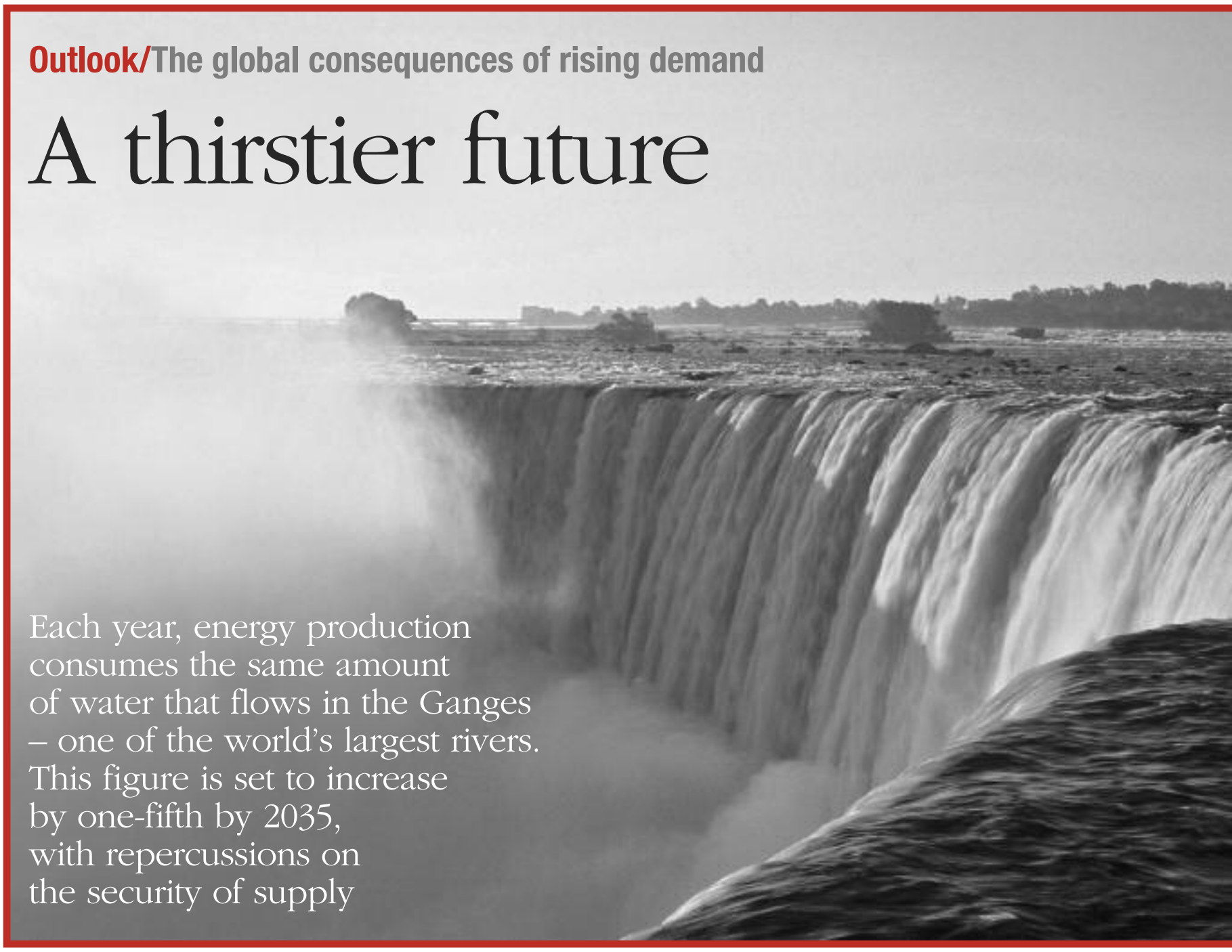
Many multinationals such as GE, Nestle, PepsiCo, Kraft, and Nike, among others, have actively committed to long term sustainability programs. However, the Anglo-Dutch consumer goods giant Unilever, and its chief executive Paul Polman in particular, are in a league of their own when it comes to challenging the corporate status quo and adopting what the company calls a 10-year Sustainable Living Plan. "Business cannot survive in a society that fails, so it is stupid to think that a business can just be standing on the sidelines of a system that gives them life in the first place," he said earlier this year. "This is not idealistic at all," he added, explaining that all the actions Unilever takes are hard-wired to its business purpose and hard-wired to its brands. So the company advocates sanitation but with its brands. For him, this is just simple common sense. One example is a water purifying system Unilever has developed that requires no gas or electricity and which Polman likes to describe as "the mobile phone"of drinking water.

Polman has called on business leaders, politicians and non-governmental organizations (NGOs) to embrace systems thinking and to recognize they cannot deal with the world's environmental and social challenges in isolation. But he also thinks that the political environment is breaking down so the need for companies to play a more active role is all the more important. The inability of world leaders to conclude pacts on addressing climate change or global trade are symptoms of the political breakdown. In the absence of tangible agreements among governments, Polman sees as a way forward for sustainability the creation of coalitions of corporations and sometimes NGOs, although he also criticizes them for often being entirely focused on a single issue.

WIDESPREAD RESPONSIBILITY

As a result of the political vacuum at the policy level, business is now in the driving seat on many initiatives such as the moratorium on illegal deforestation and water wastage. That also implies adopting a new, different business model in a society that has been re-adjusting since the financial crisis from a rules-based society back to a principles-based society. The challenge of this new business model is to show how a company gives to society and the environment rather than just taking from them. Polman sums it up with the following words: "You focus on the right things, you put the consumer in the middle of all you do, and ultimately your shareholder will benefit as well – as a result but not as an objective in itself. And hopefully we will bring the world back a little bit of sanity." He could also have added, to ensure the necessary water resources to improve the living conditions of the world's 2.5 billion people facing acute water stress and to meet the growing needs of a rising, increasingly thirsty urban population, providing – in the absence of significant progress – all the ingredients for a global storm.

A thirstier future



Each year, energy production consumes the same amount of water that flows in the Ganges – one of the world's largest rivers. This figure is set to increase by one-fifth by 2035, with repercussions on the security of supply

by FATIH BIROL

Energy and water are inextricably linked. Energy production depends on water, mainly for power generation at hydropower facilities; cooling at fossil-fuelled and nuclear power plants; irrigation to grow biomass feedstock crops; and the extraction, transport and processing of fossil fuels. The use of water for energy production can have critical impacts on freshwater resources, affecting both their availability (the amount downstream) and their quality (physical and chemical properties).

Pressures on both energy and water are set to increase. Economic growth and expanding populations, particularly in emerging economies, will drive greater demand for energy and water. Moreover, climate change portends a more water-constrained future: besides higher air and water temperatures, expected impacts include decreasing average surface water flows; a reduction of snowpack and change in the timing of the snowmelt season; sea level rise, which will contaminate freshwater supplies; and droughts, heat waves and floods that are more frequent and more severe.

RISING DEMAND AND WATER RISK

The energy sector is awakening to the important relationship between energy and water, which prompted the I.E.A.'s *World Energy Outlook (WEO)* to examine the future water requirements for energy sector operations and identify specific water resource risks that will confront it. The scale of water use for energy production is tremendous. We estimate that it is currently some 580 billion cubic meters per year. This is about 15 percent of the world's total water use, second only to agriculture. Or, to put it another way, if you were to stand on the banks of the Ganges or Mississippi Rivers – some of the very largest in the world – you could watch the water flow by at approximately the same rate it is used by the global energy sector.

Today, the vast majority of water used in the energy sector, about 90 percent, is for cooling at thermal power plants. Water is simply the most effective medium for carrying away the huge quantities of waste heat that they produce. Water requirements are highest for thermal power plants that utilize once-through cooling systems, i.e., systems that extract water from a source and pass it through, as opposed to re-circulating it in a closed system (Figure 1). Because they are so efficient, combined-cycle gas turbines use little water compared with coal-fired and nuclear power plants. Renewables, such as wind and solar PV, use virtually no water. Relative to the power sector, water used in the production of fossil fuels and biofuels appears minor on a global level, though this may not be the case in the context of local water availability and does not necessarily reflect potential risks that these activities might pose to water quality.

Looking to the future, energy sector water use (also referred to as withdrawals) rises by one-fifth between 2010 and 2035 in our projections (see Figure 2). The bulk continues to be used in power generation, mostly in coal-fired and nuclear power plants that utilize once-through cooling systems. However, after 2020 this amount starts to decline as these types of cooling systems are phased out in favor of more advanced ones, and as electricity generation from gas-fired and renewable sources expands. Water use for biofuels production, which grows by four times its present level, is a driver of the increasing overall

trend. The amount of water consumed, the component of water use that is not returned directly to the environment, increases by a more dramatic 85 percent. This is the result of the shift towards more advanced cooling systems, which minimize water use but result in higher consumption.

HISTORICAL PRECEDENTS

What does this mean for the future energy supply? Given the location-specific nature of water resources, this question must be carefully considered at the water basin level, or even at particular sites where energy is produced. The risks posed by water resources are two-fold: that at a given point in time there will not be enough of it, or that it will not be the right quality.

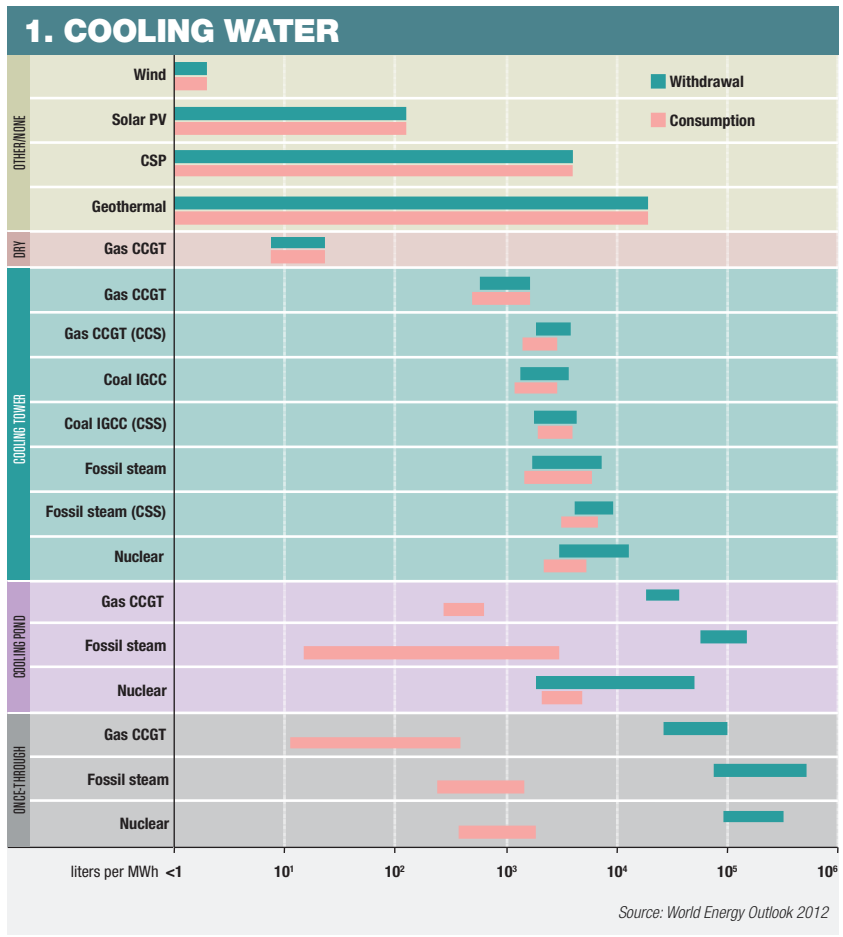
Already we have seen several large-scale examples of how energy systems are vulnerable to such constraints. In August 2012, India experienced water shortages from a delayed monsoon that simultaneously raised electricity demand (most of it for groundwater pumping to serve agricultural needs) and reduced hydropower production, contributing to blackouts that lasted several days and affected more than 600 million people. In Europe, an extended heat wave during the summer of 2003 forced utilities in France to curtail nuclear power output to prevent exceeding allowable thermal limits in nearby waterways. This resulted in a loss of output equivalent to 4-5 reactors and cost an estimated €300 million to import electricity.

Water will increasingly affect the physical, economic and environmental viability of energy projects. Power systems will continue to be a key point of vulnerability, particularly in dry parts of China, India and the United States. Public concern about the potential environmental impacts of producing unconventional gas (including on water) has prompted additional regulation and, in some jurisdictions, temporary moratoria or bans on hydraulic fracturing. The formation of rules and best practices to make sure that shale gas develops in an environmentally safe manner will play a large part in determining its future. Moreover, water availability in parts of China, which is estimated to have the world's largest shale gas resources, will strongly influence the pace of development. In Iraq, sustained increases in oil production hinge on the availability of water for injection to maintain pressure in the country's southern fields, with vital implications for Iraq's future prosperity and global oil markets.

THE ROLE OF TECHNOLOGY

Many of these challenges can be managed with existing technology; however, these can involve trade-offs such as increased costs, a reduction in energy output or alternative locations for siting of projects. In the power sector, water exposure can be reduced with greater reliance on renewable energy technologies, such as solar PV and wind, or by improving the efficiency of power plants, for instance by shifting from sub-critical coal to supercritical coal or integrated gasification combined cycle (IGCC) plants. Deployment of more advanced cooling systems can also reduce water use in power plants. In biofuels production, biomass crops and locations that have the greatest water efficiency will be advantaged. And more generally, the energy sector can look to exploit non-freshwater sources – saline water, treated wastewater, storm water and produced water from oil and gas operations – and adopt water re-use technologies.

By turning the spotlight to the relationship between energy and water, it is my hope that we can anticipate how the energy sector will need to adapt to remain robust in the face of changing energy, water and climate futures.



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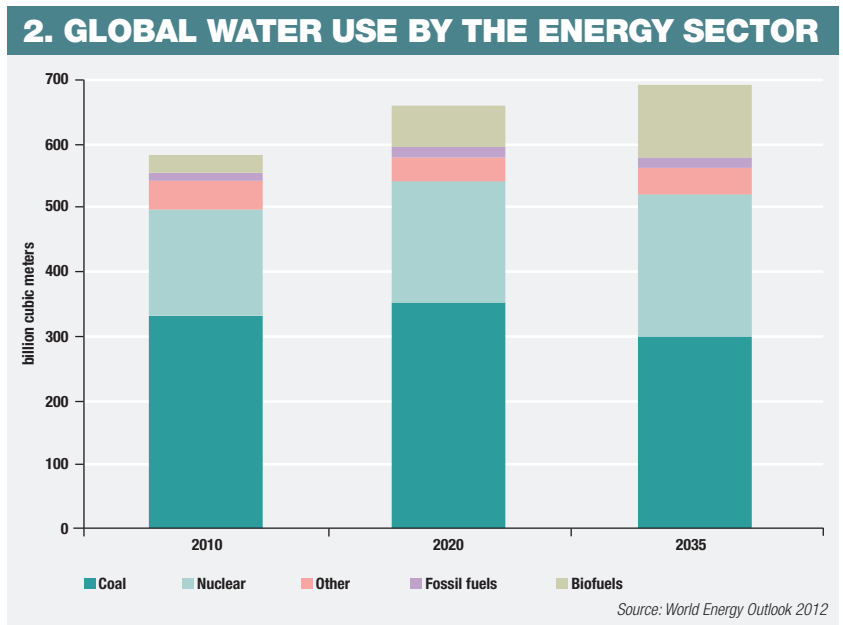
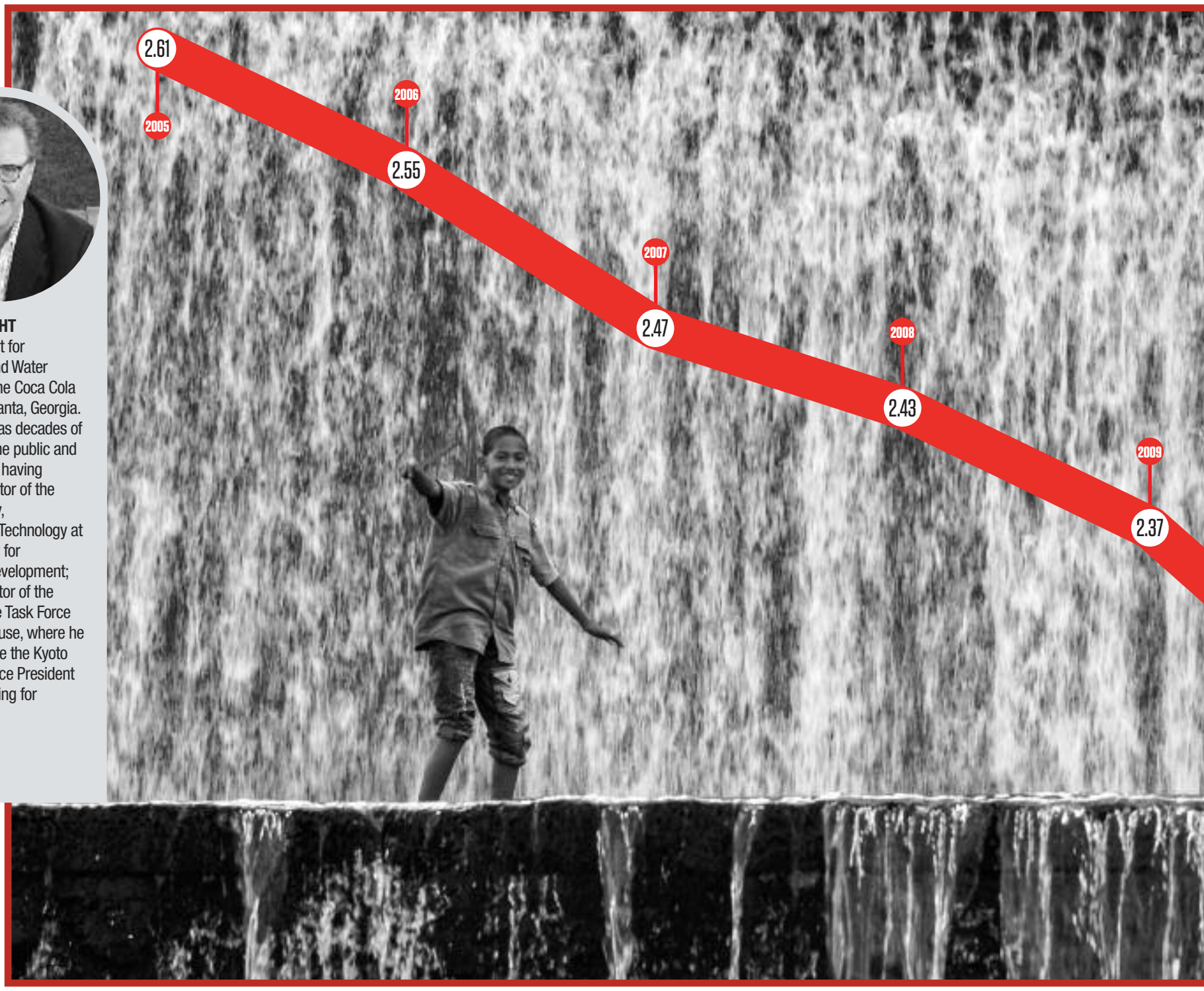


Energy sector water use (also referred to as withdrawals) will rise by one-fifth between 2010 and 2035. The bulk continues to be used in power generation, mostly in coal-fired and nuclear power plants that utilize once-through cooling systems.

Fatih Birol is the Chief Economist at the International Energy Agency in Paris. He is responsible for the IEA's flagship *World Energy Outlook* publication. He is also the founder and chair of the IEA Energy Business Council.

JEFF SEABRIGHT is Vice President for Environment and Water Resources at The Coca Cola Company in Atlanta, Georgia. Mr. Seabright has decades of experience in the public and private sectors, having served as Director of the Office of Energy, Environment & Technology at the U.S. Agency for International Development; Executive Director of the Climate Change Task Force at the White House, where he helped negotiate the Kyoto Protocol; and Vice President for Policy Planning for Texaco, Inc.



Coca-Cola/Jeff Seabright explains the company's sustainability plans

Towards water neutrality

This company is aiming to replenish 100 percent of the water used in its finished beverages by 2020. It launched the water risk survey in 2004, and has invested more than $260 million over the last five years

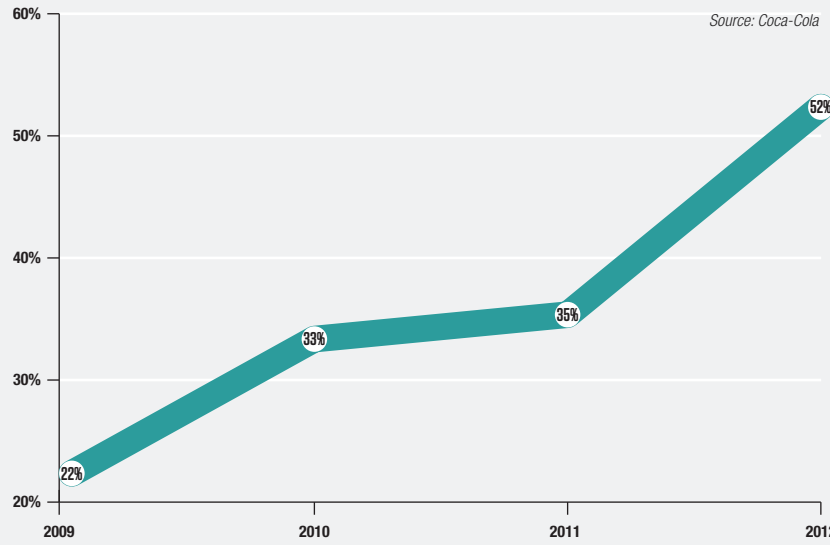
by MOLLY MOORE

The Coca-Cola Company has set itself the goal of replenishing all the water it uses in producing its beverages by 2020. As the leading non-alcoholic drinks company, with revenues of around $35 billion, Coca-Cola's core business depends on water. It has therefore recognized the importance—in ethical terms, and above all in business terms—of preserving this resource. This realization has led to the launch of a series of projects in various parts of the world, in collaboration with local administrations and international organizations: from rainwater harvesting programs in India to reforestation programs in Latin America and safe water access programs in Africa. Jeff Seabright, Coca-Cola's Vice President for Environment and Water Resources, told us about it in an exclusive interview with *Oil*.

This graph shows the rate of water consumption by the Coca-Cola System from 2005 to 2011. In 2011, the Coca-Cola System used 293.3 billion liters of water to produce 135 billion liters of product, with an index of water consumption equal to 2.16 liters of water per liter of product.

Source: Coca-Cola

REPLENISHING WATER RESOURCES



In 2012, more than half of the water Coca-Cola used in its products was replenished through programs to maintain the health of drainage basins or community sustainability projects.

What does Coca-Cola mean when it says it wants to be water neutral by 2020?

Water is the essential ingredient in every product we make and it is an input to the agricultural ingredients we use in many of our products. Without water we simply don't have a business. It's a shared resource in the communities in which we operate around the world that is that coming under increasing stress. That's why we felt both from a business and a sustainability point of view it was critically important for us to address water and to become responsible stewards for this valuable resource.

Water has been essential for the entire history of the company.

The most recent challenges we faced and the strategic direction we set reaches back to 2004 when we really began looking at water issues at the local level and getting data from our franchise operating plants around the world to put together a composite picture based on data of what were the water issues facing the business. We launched the water risk survey in 2004, where we asked each of our nearly 1000 bottling plants in over 200 countries to provide information around water issues in their markets, in six categories, with 300 questions. We got a stunning 94 percent response rate, which gave us a lot of data that we then used to go back to each of our geographic business units to really ground-truth the picture of the water issues and opportunities.

We did a deep dive. It gave us a good sense of the challenges and issues. We used that as a launching board for the rest of our strategy.

What are the company's primary projects for reaching these water sustainability goals?

What we really learned in the 2004 time frame was that the traditional issues of water quality in our product and of water efficiency in our manufacturing operations were important. But if we were really going to manage water holistically and become leaders in this space we needed to look beyond the four walls of our bottling plants to the watershed that ultimately provides water to our facilities, as well as the shared users in the communities and the ecological and social aspects of water use in the areas where we operate.

> The biggest challenge that we're facing is around some of the stress climate change will pose on the growing demands of our agricultural needs around the planet

We not only had to stretch ourselves to continue to work on the operational issues of water quality, effective waste water treatment and water use efficiency in our manufacturing, but to engage in a deeper way around some of the social challenges such as safe water access in communities that lack it.

For example, we've worked with USAID [the United States Agency for International Development] in Africa to help provide safe water to people who lack it. Lack of water has a disproportionately negative influence on women, who are often tasked with the drudgery of collecting water. Helping provide safe water to a village or community that lacked it previously changes lives not just from a health point of view, in terms of reduced disease or hydration, but with empowerment of women to do more productive things than spending four or five hours a day fetching water.

To date, in partnership with others, we have helped to provide safe water access to 1.8 million people—mostly in Africa—and have made a tangible difference in people's lives.

What did you learn about how these water sustainability challenges would affect your future business?

We're seeing more stress on water resources around the world. We look at where we have operations. Where we have operations is where the markets are, the markets are where the people are, and that's where you'd expect the pressure to be. Increasing urbanization, growing middle class, having more people on the planet: we're going to see more and more stress. It's important that we really up the game on every aspect of global resource management.

If it's not properly managed, our business will be at risk. We have a vested interested in the business. We can't do it alone. We have to work →

with partners in communities, in civil society, in governments to arrive at the solutions that are going to make a difference.

The good news is this is a doable thing. There's no undefined mysterious solution we're waiting for. We know how to do this. We know how to manage for our resources, we just need to get our act together and get focused—"we," collectively.

It's important to note that that the ways in which climate change is being manifest on the planet today is really through the water cycle, in large measure. The whole question of climate adaptation and climate impact and the question of water resource management are very tightly bound together. We really do need to be attentive to the climate debate and understand that these are the kinds of implications for our planet. The challenge is that many of the communities most at risk are those least well prepared to adapt, because they are not as well off as the Netherlands or the United States. You think about countries like Bangladesh, or the Mekong Delta region in Southeast Asia. The implications of rising sea levels and more intense weather events are presenting huge challenges for them and a lot is going to come down to water resource issues.

So how is Coca-Cola specifically addressing those challenges at its facilities around the world?

We have a requirement that if you want to be a Coca-Cola franchise bottler, you must adhere to our standards to treat the effluent water used in processing of manufacturing, bottle washing, and rinsing, and ensure that all of that process water is fully treated and returned back to nature in a way that's capable of supporting aquatic habitat. In many places countries either don't require that or have laws that do require it, but that are not enforced. We have almost 99 percent compliance that we fully treat waste water even in places where that is not required.

One of the things that came out of our strategy of looking at watersheds outside the four walls of our plants was the requirement to have each of our physical manufacturing plants—and there are nearly 1000 around the world—put in place a source-water protection plan.

That means plant managers have to work with local experts to assess and understand the watershed in which they operate. They have to get the information: Where is the water coming from? What are the stresses the watershed is facing? What are some of the challenges and other shared users of that watershed—agriculture, other industrial users, etc.?

SYSTEM WATER USE RATIO (EFFICIENCY) BY REGION

Eurasia & Africa	2.53
Europe	1.85
Latin America	2.01
North America	1.74
Pacific	2.76
Global	2.16

WATER USE BY SOURCE (billion liters)

Ground/surface water	149.4
Municipal water	118.7
Other water/ rain water	25.2
Total	293.3

Source: Coca-Cola

The water use ratio—i.e., the amount of water used per liter of product produced—measures the efficiency of Coca-Cola's system. The highest water use ratios are often in developing markets, where water risks may be higher. Water use by source shows that, of the 293 billion liters of water used by Coca-Cola in 2011, around half came from ground/surface water.

We require each plant manager to determine what level of stress exists in that watershed and, depending on the level of stress or risk, they've got to put in place a plan to protect that source of water.

In India, that may take the shape of working with local farmers to introduce drip irrigation technology rather than simply flooding the fields by over-pumping the aquifers. Or it may involve reforesting part of the Atlantic rainforest to help recharge the aquifer by retaining rainfall in Brazil. Whatever the source-water protection plan indicates is a risk, we require local managers to get on top of that and to actually formulate a plan to work in the community. A great deal of our replenish projects are generated through the source-water protection plan. This is how we work to protect our business, by making sure that the resource is sustainable for the community in which we operate.

At the end of the day, if there is not enough water for the community, we are not going to get the water and we both suffer.

Does Coca-Cola finance some of these local projects in areas where communities cannot afford to do so?

Yes, we do. In the case of India, we work with the local municipality to help support subsidization of drip irrigation piping for farmers to make it more affordable for them. Why? That will help the watershed be more sustainable because they won't be overusing it for crops and that will prevent the premature write-off of a Coca-Cola bottling plant—so it's good business for us to help those farmers.

We share that cost with our bottling partners, local community organizations and municipal governments.

How does Coca-Cola make certain that all its local franchises around the world are complying with these standards?

This source-water protection plan is a requirement we enforce across franchise bottlers. We audit, and the intention is 100 percent of facilities will come into full compliance. This is a requirement that was added as we learned more about the challenges of managing watersheds. Previously our audits focused on things like quality, safety, and waste water treatment in the plant. Now we are adding to that: Do you have an adequate source-water protection plan with the community, to protect the source water that sustains your business? It's a requirement, just like every other business requirement. If you are out of compliance with company requirements there are consequences. This is about assuring the viability of the business by engaging in shared resource solutions.

How much does Coca Cola invest each year in water sustainability projects?

Over the last five years, together with our partners, we've given more than $260 million.

Where are the greatest challenges for meeting your 2020 goals both geographically and socioeconomically?

For our replenish goal—which is to give back as much water as we use in our production by 2020—we were at 52 percent in 2012. Of course we are continuing to grow our business, which means the more we grow the more we give back. We are on track to meet that goal by 2020, and we're doing it by a variety of means, including rainwater harvesting programs in India, through reforestation programs in Latin America and through safe water access programs in Africa.

The biggest challenge that we're collectively facing around water resource management—and it's not just Coca-Cola, it's all of us—increasingly is around agriculture and some of the stress climate change will pose on the growing demands of our agricultural needs around the planet.

More intense heat waves, more intense drought, more intense downpours, and severe weather are some of the challenges coming with climate change that are really going to impact agriculture in a significant way.

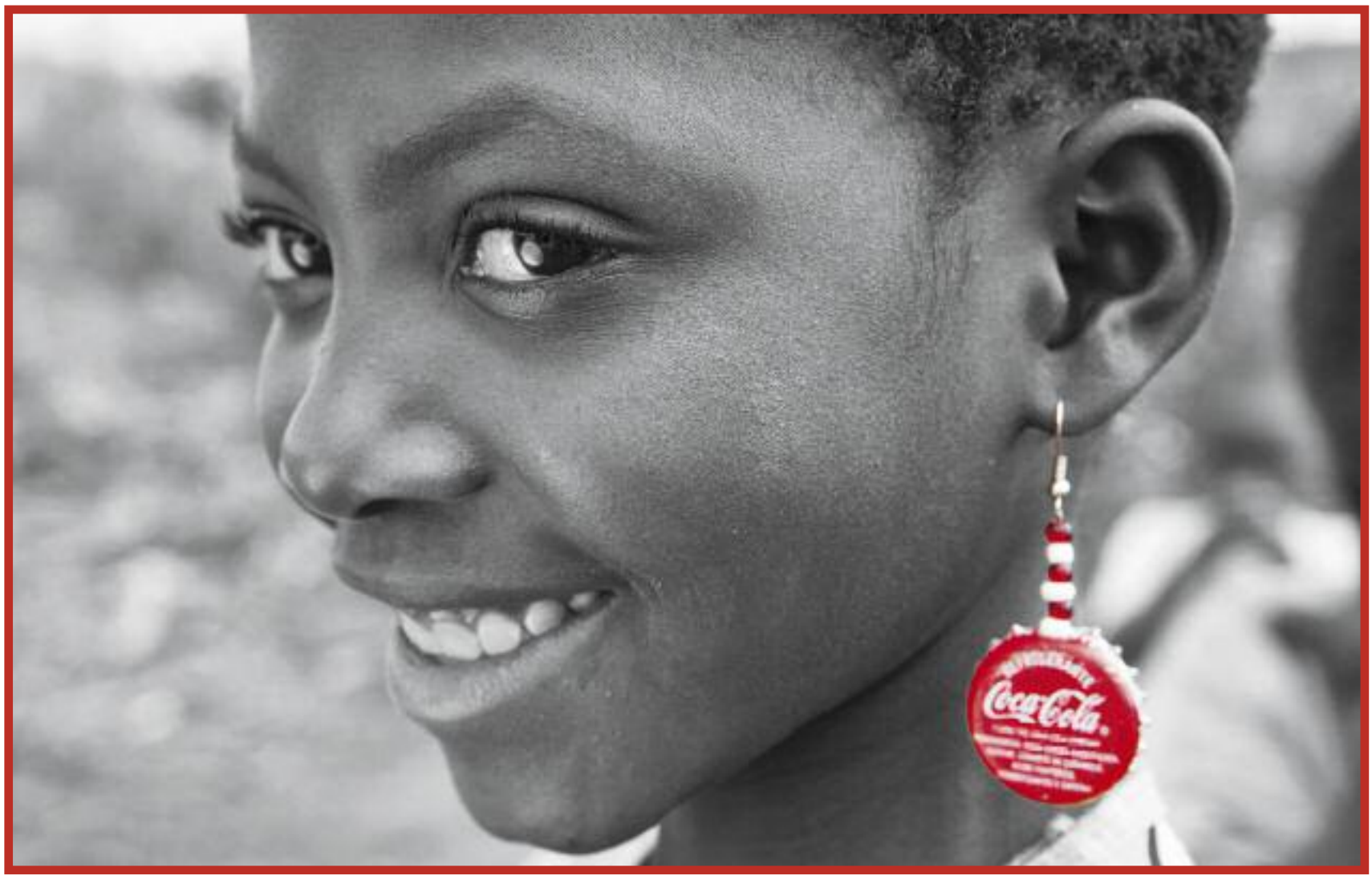
Something on the order of 70-75 percent of fresh water use on the planet is for agriculture. More resource management in agricultural productivity in a climate-changed world is going to be the biggest challenge.

How is Coca-Cola tackling that?

We're working with our suppliers to become more water efficient in our agricultural ingredients. We've worked closely with World Wildlife Fund and a host of other organizations to help create the first ever sustainable standard for sugar cane cultivation and production. Sugar is a very thirsty crop.

We help put forward a standard of best practice or for sustainable farming for sugar cane, from our point of view—which includes water efficiency—but also from the social labor point of view, as well in terms of making sure workplace rights are respected.

Is it more or less difficult to get the agricultural sector



on board than other types of water sustainability?

Agriculture is the lifeblood of many economies and emerging markets. It's very much based on traditional approaches and methods and sometimes addressing that is a challenge. It's time-consuming work, but it's critically important, not just for sustainability, but we're helping to improve and make more resilient the farmers that are the front lines of our supply chain. Helping them gain best practices and become more productive and more resource efficient providers of agricultural ingredients will bring them closer to us and make them more successful as farmers. It's investing in our own business.

How did World Wildlife Fund and Coca-Cola develop a partnership based on water sustainability?

It's relationship we've had going back to 2000 when we began doing some work with them in the Southeast of the United States on a very local project helping conserve fresh water resources of the rivers and streams which are very bio-diverse aquatic habitats. We continued to work with them and gain expertise and insight from them and together explore how we could expand this local Southeast partnership to a more global one. We simultaneously were engaged with WWF in Europe on some water efficiency programs.

In 2007 we came together to outline a more global partnership around seven river basins. We announced we were going to set big ambitious goals along the way on carbon, on water efficiency.

We benefited enormously from the relationship with WWF. They have the resource expertise in watersheds around the world. We started with about a dozen countries involved in river basin work; at the end of 2012, WWF and Coca-Cola were working in partnership in 49 countries.

Coca-Cola is in 200 countries and is pretty ubiquitous. WWF is the largest environmental organization in approximately 100 countries. Their physical presence and expertise and local knowledge married with our local expertise and knowledge has been a unique combination.

Our work with WWF really begins at the local bottling level. What are the implications for conservation for the bottling plants that operate in the Yangtze basin? How do we engage the local plants and employees? And we go out from there, so it's not just drawing a circle around the plants and saying that's what it's all about.

What's is the local community's reaction to you when you start requiring these conservation efforts?

The thing about Coke is that we are a global brand. It's more than Coke –it's juices and other non-alcoholic beverages, coffee, tea. But we are an intensely local business based on a franchise model. The Coca-Cola bottler in Rwanda is owned by Rwandans and run by local people.

They have to adhere to our standards around quality, around environment, around workplace rights. There is a lot of interaction between Coca-Cola and our franchisees to make sure they are doing business the right way and making products the right way. As a result of that professional training, presence and standards, when we started elevating our work around water, entities like USAID and others were very anxious to work with us because they know that we have local presence that will stand by these projects and make sure they have all the right elements for success.

We're not just helicoptering in and helicoptering out. We're local. And that means we have a vested interest in making sure these projects succeed. Many of our partners are more interested in working with us for our local presence than they are for our money.

We're not outsiders, we're insiders. When we talk about the work that we're doing in any of these markets, it's not me in Atlanta flying in and having a conversation about conserving the river basin. It's the local Coca-Cola team in China, the local bottling partners in China who are part of the community, meeting with their cousins and college professors. We are physically there because of this franchise model. It's based on local franchise ownership and engagement.

A GLOBAL BRAND

Coca-Cola is a global brand but it also has a strong local presence because of its franchising model, which is based on local ownership and accountability.

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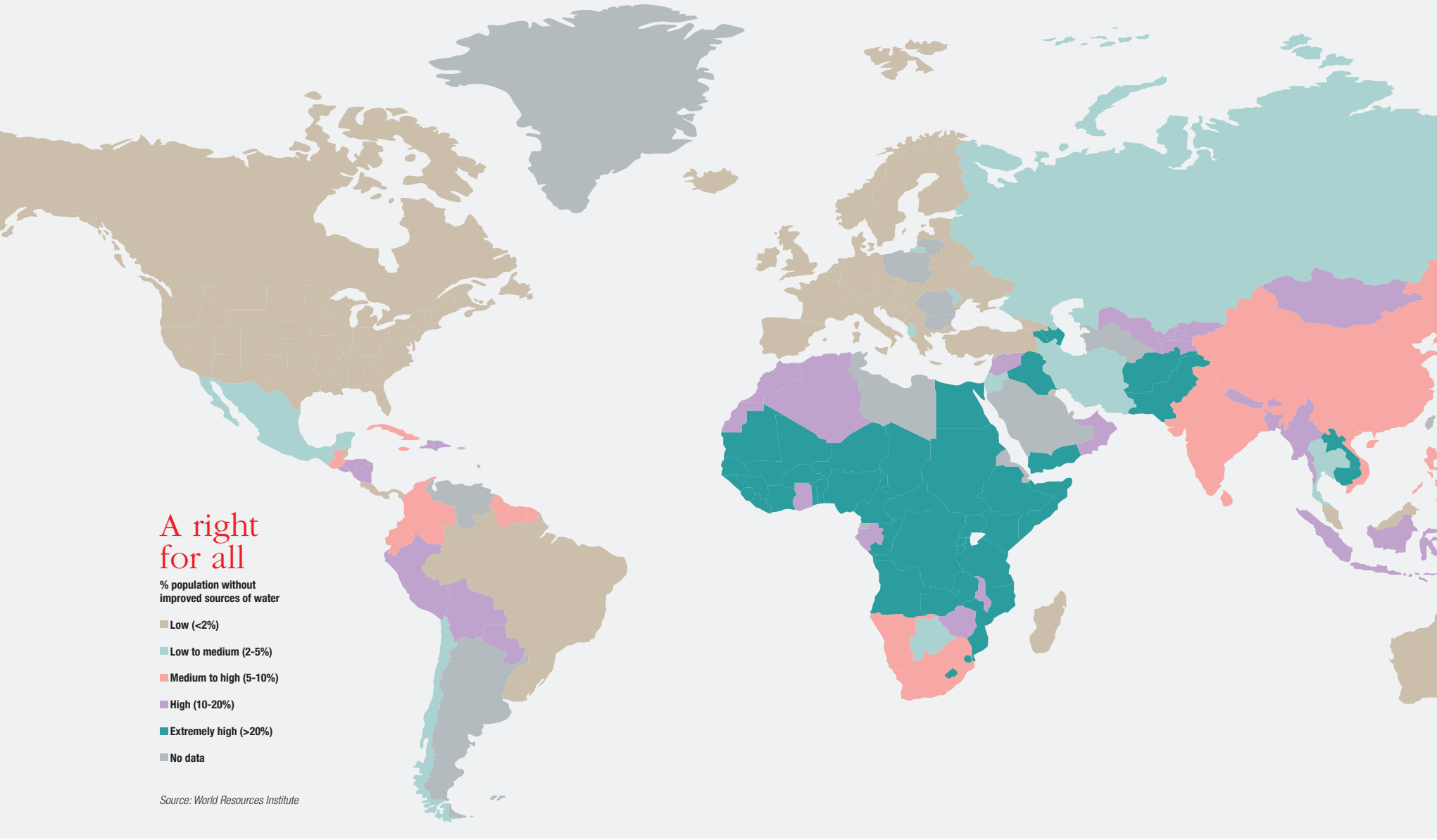


WWF/A billion people without access to water: an interview with Suzanne Apple

Working together for a sustainable future

Collaboration between environmental associations and the private sector can play a crucial role in safeguarding the planet. New cooperation projects aim to improve companies' sourcing policies

by MOLLY MOORE

More than a billion people do not currently have access to fresh water. By 2050, the global population is expected to reach 9 billion, putting an even greater strain on this precious resource. Faced with these worrying figures, Suzanne Apple, Vice President of Business and Industry at the World Wildlife Fund (WWF), points out that collaboration with major corporations could make the difference in terms of preserving water resources and protecting communities.

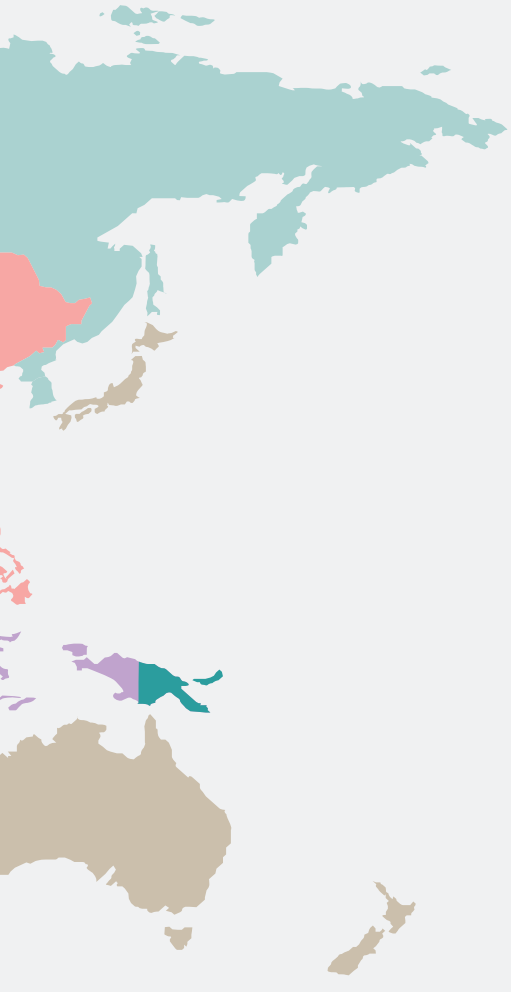
How does World Wildlife Fund choose its corporate partners?

WWF works with companies that can advance our mission. Specifically, we target companies that source specific commodities from our priority regions, and we work with those companies to improve their sourcing policies. This can have an immediate positive impact for the places and species we want to conserve.

We also work with companies on issues of global importance, like water and climate. We recognize that we cannot achieve our mission alone and that the corporate sector can play an important role in conserving the planet with us. The idea is to have the maximum impact possible.

Why did WWF enter a corporate partnership with Coca-Cola in particular?

The Coca-Cola Company has supported WWF's conservation efforts for years. It is also the world's largest beverage company, and the company is acutely aware that its business depends on viable fresh water systems. Water is the primary ingredient in every product Coca-Cola makes and is essential to the ingredients it buys. Conserving freshwater resources is a top prior-



ity for WWF. With this common goal in mind, we saw a real opportunity to work together to help conserve the world's fresh-water resources while making meaningful improvements within the company's operations and supply chain.

How did the two companies arrive at a partnership based on water sustainability?

Fresh-water resources are essential to Coca-Cola's business and a conservation priority for WWF. Without healthy, resilient freshwater systems, Coca-Cola does not have a business; and species, nature and communities suffer. We are already seeing water shortages in dozens of countries around the world. So it was an obvious starting point for the partnership.

Working together, we think we can make a real difference toward achieving more sustainable water management practices around the world.

We are combining WWF's expertise on conservation planning, sustainable supply chains, as well as our on-the-ground presence with Coca-Cola's technical knowledge, extensive franchise system and its understanding of the commercial systems and vast networks.

How important is water sustainability to WWF's overall goals and objectives?

The mission of WWF is to protect natural areas and wild populations of plants and animals; promote sustainable approaches to the use of renewable natural resources; and promote more efficient use of resources and energy and the maximum reduction of pollution.

Fresh water conservation is a priority for WWF – fresh water is vital to life, and yet it is a finite resource. Only three percent of the world's water is fresh water, and most of that is frozen in glaciers or otherwise unavailable. In the present day, there already isn't enough to go around. More than a billion people lack access to water. By 2050, the population is expected to grow to 9 billion, putting an even greater strain on freshwater resources. We need to find new and long-lasting solutions if people and nature are to benefit from these resources in the next century. Further degradation is not an option.

What do you consider the most significant joint water sustainability project ongoing currently with WWF and Coca-Cola?

WWF and Coca-Cola are working together to conserve some of the world's most important places spanning Asia, Africa, and the Americas, with a focus on the Mesoamerican Reef, the Yangtze River and nine other locations. Working in these regions, we plan to more deeply engage Coca-Cola's strategic supply chains and involve additional partners. We're aiming to really integrate our efforts through a comprehensive watershed approach that goes beyond efficiency and helps maintain healthy, resilient river basins.

One area that I find really exciting is the work we're doing around valuing nature. We know that fresh-water ecosystems provide a multitude of benefits – like flood control, climate regulation and drinking water – yet we overuse and degrade these ecosystems.

Some of the work we're doing together will be to develop models and approaches to evaluate tradeoffs and synergies between conserving biodiversity, supplying ecosystem services and minimizing costs. By providing sound ecological, social and economic reasons to incorporate biodiversity and ecosystem services into decision-making processes, we will create the quantitative tools needed to enable the private sector to account for and invest in natural capital.

How does WWF benefit from the partnership other than financially?

WWF benefits in several ways. One is through the conservation targets that we set with Coca-Cola to help address common goals – like reductions to greenhouse gas emissions, or sustainable sourcing of agricultural ingredients that have positive environmental benefits. We also benefit from Coca-Cola's technical knowledge to make improvements to manufacturing operations. Coca-Cola's global reach and their ties to governments and other organizations is another benefit for WWF and our work with The Coca-Cola Company, as often these are audiences we cannot reach on our own. Finally, by working with Coca-Cola, we have the opportunity to conduct valuable on-the-ground research to fill scientific gaps – developing models, designing tools and creating a framework that could work for other conservation projects.

Is there a growing trend among environmental groups to partner with corporations? If so, why?

I know from a WWF perspective, we have been engaging business for more than 10 years, so it is not new for us. I do think the way in which companies and environmental groups are working together is shifting – at least that is what we have seen with WWF's corporate partnerships and with a few other key NGOs.

We are seeing deeper collaborations that really take the involvement of both organizations to a level beyond a donor and delivery agent relationship, and these partnerships are having real impacts on conservation and the company's bottom line.

There's also a shift to looking beyond the four walls of the company – considering the supply chain, the community, and the broader ecosystem in which a company operates. That's no small task, and takes dedicated partners that have on-the-ground presence, like WWF. More and more, leading companies are recognizing their unique role in and contribution to a sustainable future, and environmental groups like WWF have the expertise to help guide them on that journey.

Why does WWF consider it important to work with corporations? How will working with corporations benefit the planet and its wildlife in the short term, and the long term?

Companies can, and do, have significant impacts on our planet, so we work with them to help them make better business decisions, understand the value of nature and the services that it provides, and ultimately to protect those resources on which it depends.

We work to unite key industry players to support sustainable standards and programs, promote better management practices and increase the supply of sustainable products.

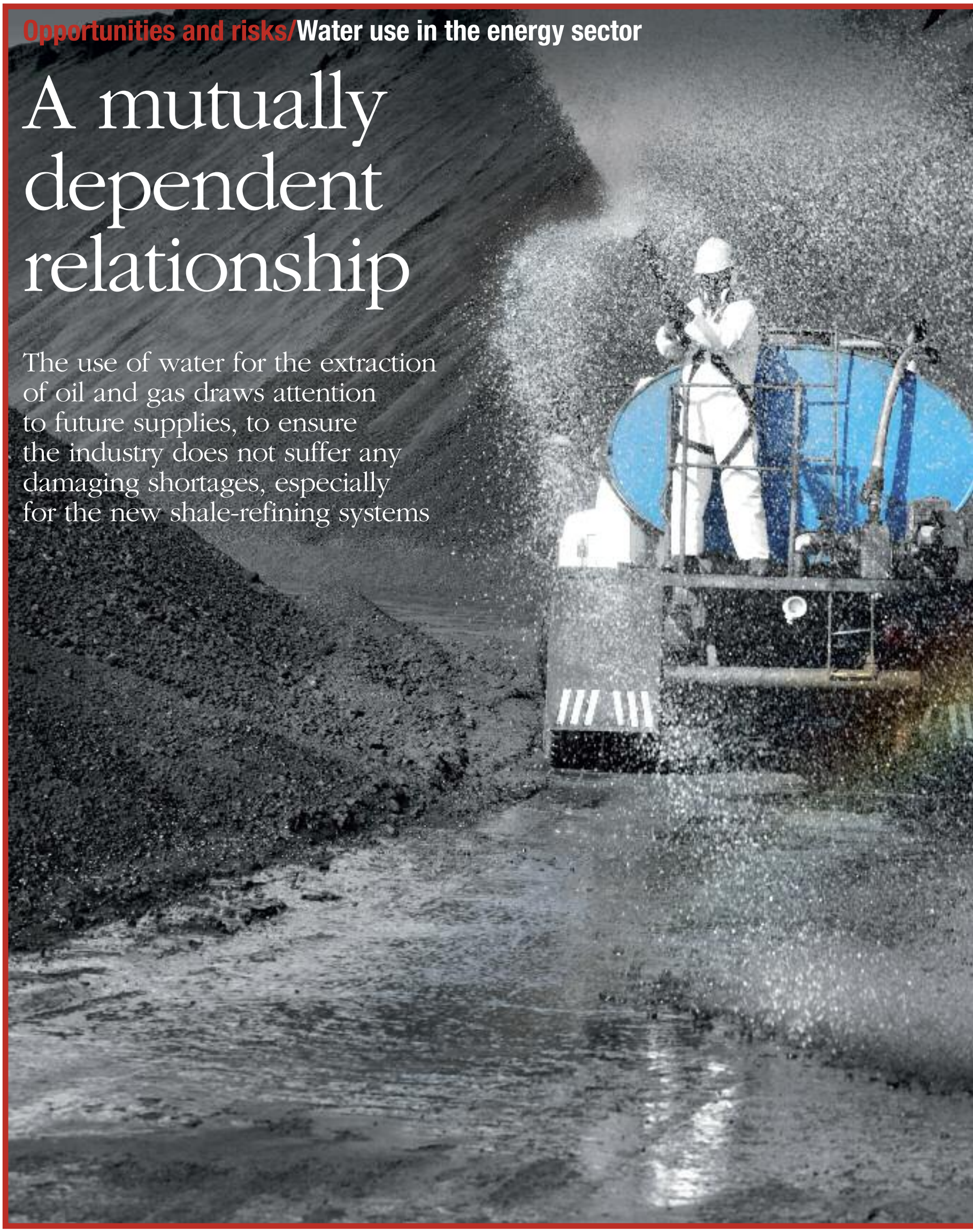
In the short term, we can develop one-on-one engagements with leading companies that have broad influence throughout the company and its supply chain – from producers to consumers. In the long term, we hope to shift global markets, transforming the global marketplace from enemy to ally in the fight for conservation.

This benefits species, ecosystems, people and businesses because they are all connected. WWF has an ambitious conservation mission—to measurably conserve the world's most biologically diverse and ecologically important places. We work with many partners, including the private sector, because we know we can't accomplish our mission without them.

SUZANNE APPLE
is Vice President, Business and Industry, World Wildlife Fund. She came to WWF from a career in the corporate world including Vice President for Community Affairs and Environmental Programs at The Home Depot. Suzanne's area of expertise are: environmental sustainability planning and management; supply chain assessment including supplier outreach and buyer education; environmentally responsible purchasing policies, i.e., sustainable forestry and forest products; communications.

A mutually dependent relationship

The use of water for the extraction of oil and gas draws attention to future supplies, to ensure the industry does not suffer any damaging shortages, especially for the new shale-refining systems



What a lot of people do not know is that the oil industry not only uses a lot of water, but it also produces a lot of water. When oil is taken out of the ground, especially in the conventional production of oil, water also often comes up with it. In some wells more water is produced than oil.

by PAUL SULLIVAN

WATER IN CONVENTIONAL OIL EXPLORATION AND PRODUCTION

The water that is produced from the well sometimes is treated or placed in storage ponds. Much of it is sent right back down into the wells as part of enhanced oil recovery projects. There are also many places that have strict regulations on how to treat this water prior to discharge and reinjection. This treatment is extremely costly to the industry.

However, in places where water is now scarce or where water will become increasingly scarce there are different calculations to be made about whether to treat it or not. There may be considerable local political pressure to have the water available for agriculture and other uses, such as power generation, which is a huge consumer of water globally.

Oil wells in water scarce areas will likely increasingly have to justify their water use and also how the produced water is treated and made available for other uses. If global climate change has some of the results that many scientists claim there →

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Global trends in the use of different drinking water sources

PERCENTAGE

FACILITY TYPE	URBAN (%)		RURAL (%)		TOTAL (%)	
	1990	2010	1990	2010	1990	2010
Piped on premises	81	80	18	29	45	54
Public taps	5	6	6	8	5	7
Boreholes	6	8	29	30	19	18
Rainwater	0	0	1	2	1	1
Dug wells	5	4	27	19	18	12
Springs	1	1	8	6	5	4
Tanker trucks and small carts with drums	1	1	1	1	1	1
Surface water	1	0	10	5	6	3
Bottled water*	1	6	0	1	1	3

POPULATION

FACILITY TYPE	URBAN (million)		RURAL (million)		TOTAL (million)	
	1990	2010	1990	2010	1990	2010
Piped on premises	1,820	2,763	538	973	2,358	3,737
Public taps	120	205	168	260	288	465
Boreholes	138	255	878	996	1,016	1,251
Rainwater	6	13	41	76	47	89
Dug wells	111	151	843	656	954	807
Springs	15	33	235	221	250	254
Tanker trucks and small carts with drums	24	42	20	43	44	85
Surface water	17	11	313	175	331	187
Bottled water*	26	192	11	36	37	228

**Survey data show that most people who use bottled water as their main source of drinking water also have piped water on premises as a secondary source. Bottled-water users are counted under the category "piped on premises" in the table above.*

Source: UNICEF

might be then oil companies will be under increasing pressure worldwide to more efficiently and effectively use, treat and send out their produced water.

Water is also used in enhanced oil recovery techniques. When conventional oil fields have been producing for some time the pressure of the wells can drop. The oil, gas, and water were taken out of a specific area underground. This area could be filled in constantly with underground water pouring in from deep water wells connected with the oil and gas field, but sometimes this does not happen and the oil company needs to send something down to build the pressure back up. Water is often sent down. Often that water is the water that has been produced from the well itself. Sometimes it is sea water as Saudi Arabia and others have done frequently. Sometimes it is from a source of briny water nearby or even municipal wastewater. Sometimes it is fresh water from a nearby aquifer or surface source. As one could readily see as water becomes scarcer in an area the oil company will need to look into other methods of enhanced oil recovery beyond water injection and reinjection.

There are many other such methods including injection of natural gas, nitrogen and carbon dioxide. Another method is by injecting chemicals or microbes that can increase the flow of the oil. Heat can also be sent down as steam or other sources. Controlled underground combustion could also be used to get the oil to flow more easily. Injecting certain kinds of polymers for enhanced oil recovery in conventional fields uses many times more water than any of these other methods.

As time goes on, if climate change picks up pace CO^2 injection may become more popular, especially in areas with increasingly water shortages. An increasingly important method may be the injection of CO^2 super fluids, liquefied CO^2, into very deep wells. However, carbon capture and sequestration use a lot of water to strip CO^2 the flue gases of electricity plants and other facilities.

Many fields in use today were found a long time ago. Enhanced oil recovery uses a lot more water per barrel extracted than that used to get the oil out in a well's earlier stages.

WATER IN UNCONVENTIONAL OIL EXPLORATION AND PRODUCTION

The extraction of unconventional oil, such as shale oil, oil shale and oil sands requires a lot of water, but it different ways than for conventional oil production. The processing of oil shale requires a lot of water in the

retorting process to turn the kerogen to something akin to crude oil as we know it. Also, it is often the case that a lot of water has to be pumped out of the oil shale fields in order to extract the shale and its oil properly. If the heating of the shale is done in situ and without steam, this can reduce water use considerably. If it is done with steam and either in situ or for the mechanically extracted oil shale, then the uses of water increase considerably.

Shale oil is not the same as oil shale. Shale oil is crude oil trapped in shale as a source rock. The method used to get this up is multistage hydraulic fracturing. A considerable amount of water is mixed with sand and some chemicals, with chemicals being a tiny proportion of the total mix, to make a fracking fluid. This fracking fluid mixture is sent into the cracks in the source rock that were created by multiple deep underground explosions along the pipeline's path. Depending on the depth of the source rock and the numbers of fracking stages needed massive amounts of water will be needed. Geology can also determine water needs. The more clay like the soil is the more water that will be needed to extract the oil, for example.

There could be a considerable amount of flowback water. This is water from the fracking fluid that comes back up during production. Many companies have found that even the less than fully treated flowback oil can be used for further fracking. This reduces water treatment costs and also costs for moving and storing the water and fracking fluids.

The production of oil sands also requires a lot of water. Extraction in situ reduces the water needs considerably compared to water use by mining the oil sands. In situ extraction of oil sands in Canada, the biggest producer of oil sands oil, is increasingly the method of choice. Water use in this method is generally done by sending steam down to the underground oil sands to loosen the bitumen out of the sands and increase its movement. Water use in extracting the oil from the oil sands after mining it (digging it up) is usually via sending steam into huge piles of oil sands and then extracting the bitumen seeping from it. Oil sands produced from both methods needs to be further refined in order to create the synthetic crude that will result.

WATER IN THE TRANSPORT AND REFINING OF OIL

After the crude oil is produced either conventionally or unconventionally it needs to be transported to refineries and storage tanks. Although in much smaller amounts than for enhanced oil recovery, water is used to clean the equipment and personnel, dust control, etc. all along the value chain of oil. The amounts used for these will differ according to how much rain is about, temperatures, the amount of dust in the air, and so forth. In places with severe water scarcity these uses may have to be accomplished in very efficient manners. Water is also used to clean out pipelines, storage tanks, tankers, barges, trains, and more.

Huge amounts of water are used in oil refinery systems. Water is used in the boilers for refineries. It is used in the desalting of the feedstock crude. Crude can be quite salty and salts are not the best things to have moving around refinery pipes. Water is also used in the cooling systems of the refinery. It is also used to clean up the refinery, to control dust and so forth. The largest uses of water in refineries are for the boilers and the cooling systems.

WATER FOR TRANSPORTATION FUELS

The water used in the overall production cycles for ethanol from irrigated corn and soybeans is far greater than the water use to conventionally produce gasoline from crude oil. Water use in a crude refinery can be about 12th of the water use in a corn ethanol refinery per unit of energy produced. Water used to produce the corn for the biofuel refinery could be hundreds of times more than water used to explore and produce the same amount of energy from conventional crude oil. Gasoline and diesel fuels produced from oil sands, shale oil, oil shale, synthetic liquid fuels from natural gas use more water than gasoline made from conventional crude in the conventional ways. It normally takes less water to make diesel than gasoline.

The IEA points out that the largest user of water in the energy industry is coal power by far. Biofuels are next. Next in line is the combination of oil and gas. The IEA forecasts that coal's share of energy in the world will surpass that of oil in the next 4 years or so. The IEA also expects that biofuels will grow tremendously. These trends will vastly increase the use of water in the energy industry.

The use of water in the production of transportation fuels is expected to grow more than 100 percent next 15 years. Oil-based transportation fuels will be a significant part of that growth, but the "alternative" fuels like ethanol, bio-diesel, and even the electric car could be much bigger drivers in this massive increase in water use.

WATER IN AGRICULTURE AND SANITATION

Globally the biggest extraction of water is agriculture by far at about 70 percent. Energy is about 8 percent of all water withdrawals globally. In developed countries like the United States energy uses a bit over 40 percent of water withdrawals. Thermoelectric cooling water withdrawals far surpass those for oil and gas in these developed countries. Pollution to water sources is likely far greater from agricultural uses than energy uses given how dominant agriculture is in overall water use.

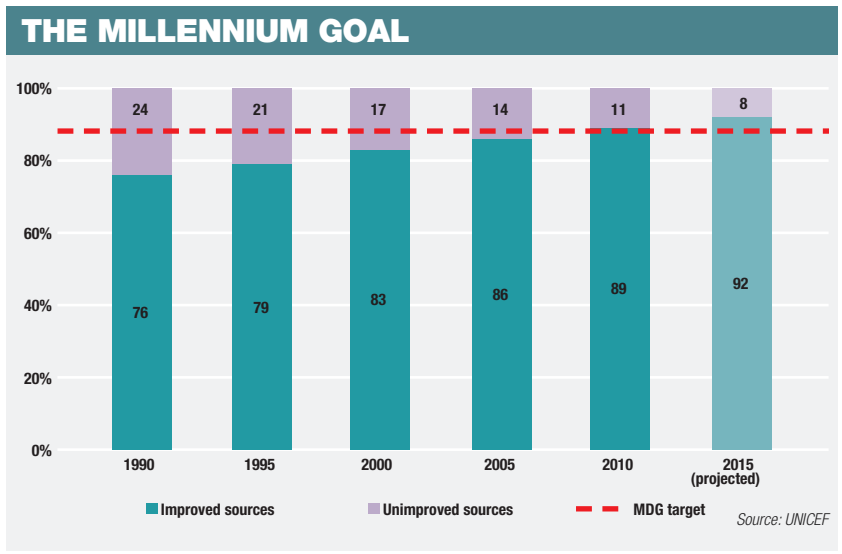
To be thoroughly realistic one of the most damaging uses of water is by human beings for improper sanitation in places like sub-Saharan Africa. About 5,000 children die each day from filthy water in Sub-Saharan Africa alone. I do not hear of such deaths from the water use in the oil, gas, coal, and other energy industries. It would not be that expensive to help bring clean water to the children of Africa. This could be a major public relations victory if the energy industry got involved with that.

SOME FINAL THOUGHTS

The changes in the water cycles and water sources that are being predicted should make everyone in the oil industry wary about the future. Consider a refinery near a dried up aquifer or river. A one percent decrease in water flow to a hydropower dam could cause a 3 percent drop in its electricity production under some circumstances. Consider what would need to be done if the shale gas revolution was held up by serious droughts in many parts of the world where the shale gas plays are found. Consider how the oil industry could be affected by increased vigilance and much tougher water regulations at local, state, national and other levels. Consider the costs of not dealing with the potential water problems of the future.

The connections between water and oil are complex. The oil industry also relies a lot on other water using industries like electricity generation. A proper set of policies should consider many nexus issues across many industries and many resources, not just between water and oil.

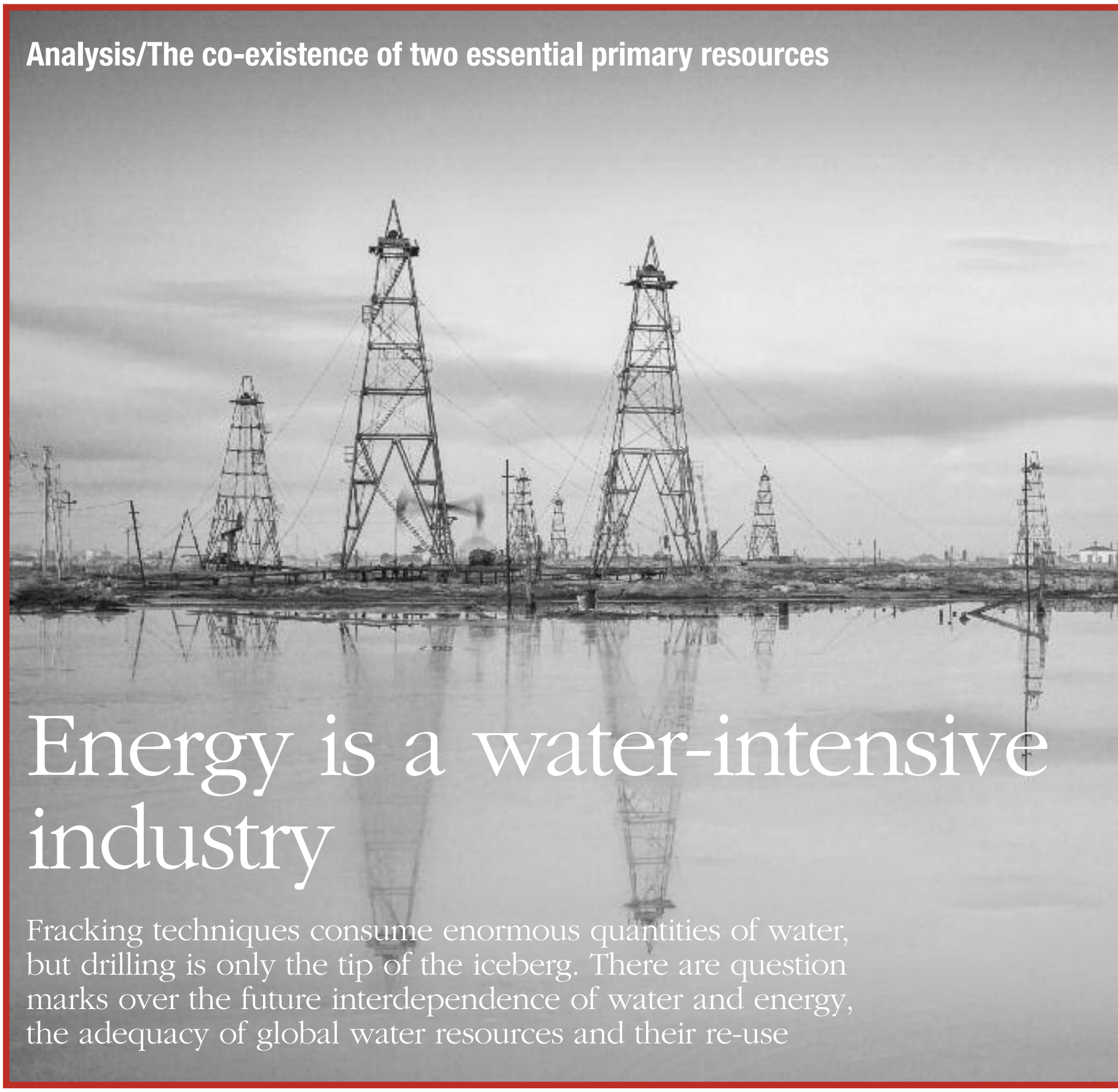
We neglect the nuanced and recursive nature of these connections at our peril.



Over 2 billion people gained access to improved water sources from 1990 to 2010: the Millennium Development Goals drinking water target has been reached. The proportion of the global population still using unimproved sources is estimated at only 11 percent.

All opinions expressed are Dr. Sullivan's alone.

On www.abo.net, read further articles about the same issue by Peter Brabeck-Lethmate, Antonio Galdo, Marco De Martino.



Energy is a water-intensive industry

Fracking techniques consume enormous quantities of water, but drilling is only the tip of the iceberg. There are question marks over the future interdependence of water and energy, the adequacy of global water resources and their re-use

by EDWARD L. MORSE

As the environmental movement has come to learn, oil and water do mix, sometimes too often, unless strict procedural drilling and production standards are met.

Fracking techniques alone consume a tremendous amount of water. On average, according to the *Oil and Gas Journal*, typical deep shale wells each consume up to 5 million gallons of water. Last year some 44,000 wells were drilled in the U.S., of which 10,200 were for shale oil or gas, consuming some 140-million gallons of water each day, or a cool 51 trillion gallons per year. But that's only about 0.3 percent of total annual water withdrawals in the U.S. That amounts to as much as is consumed in New York City in about a half a year, or irrigating 5000 acres of corn in a full year, or cooling a 1000 MW thermal power plant for 14 years, or watering a typical golf course for 700 years.

MULTIPLE INTERCONNECTIONS

But drilling alone barely touches the connections between water and energy. Oil, natural gas and coal drilling and mining combined are estimated to withdraw now more than one percent of fresh water used in the United States, where data on water use is most readily available. To be sure, the largest use of fresh water is in irrigation, most of which is in the agricultural sector, and the remainder in recreational and household/commercial use. But thermoelectric use is nearly as much as irrigation, and the two uses combined account for about 80 percent of total use. When it comes to electricity, much of the use of water is for cooling power plants, but environmental requirements to scrub coal to make it more environmentally friendly are also large.

The table "H_2O: uses and impact on quality"[1] (see page 29) summarizes the multiple connections between water and energy and comes from a U.S. Congressionally mandated study published by the Sandia Laboratory, an arm of the U.S. Department of En-

ergy, in 2006. That table notes that solar, photovoltaic, and wind, which along with hydroelectric are the main sources of renewable energy, have minimal use of water. But even when that study was completed, it was known that other alternatives to carbon-intensive uses were water-intensive, including of course nuclear power, whose water requirements are even greater than those of conventional thermal power plants, as well as concentrated solar power (CSP) and carbon capture and sequestration (CCS).

At first blush, it would appear that the main issue with the interdependency between energy and water, like that between agriculture and water, is the resilience of the fresh-water system, not just in the United States (and not just in Canada, where water use by industry actually dwarfs that in the economic giant to its south) but globally. And yes, competition for the earth's water resources and drawdowns in fresh-water lakes and ground water have given rise to efforts to develop best practices designed to preserve the availability of fresh water and the recapture and recycling of water once used.

CLIMATE CHANGE

Competition for fresh water has become a special concern for climate change, as it gives rise potentially to desertification at a time when greater water usage can turn groundwater salty, sparse and unsustainable, and where increasingly reliable and depressing data are being collected via the United Nations' Intergovernmental Panel on Climate Change (the UNIPCC).

On top of this, there is the mirror image angle to the water intensity of energy – it is the energy intensity of the water business, or the use of energy to move water, a problem that is growing as a function of development and the need to move water from its sources to its end users, and – in the Middle East and other parts of the world – the need to use energy to make fresh water from sea water. Already, in California, some 20 percent of total energy use is for purifying and transporting water.

Water investment has also become a topic for the financial community. At Citi, I have more than two dozen colleagues in research examining water issues, with the water-energy interconnect a "compelling mega-trend theme," and where they identify technologies being developed commercially to mitigate these issues as well as those identified below, and where public-private partnerships are being implemented across the planet.[2]

FOUR HARMFUL USES

Not to diminish the importance of efforts at conservation, a significantly greater problem when it comes to the energy/water nexus is a set of four uses of water in the energy system that can be significantly noxious and environmentally contaminating. In addition to shale exploitation, which has been the focus of considerable recent attention, these are coal (and other mining activities), biofuels, and oil sands. And here the issue is less the adequacy of the earth's water resources →

H_2O: uses and impact on quality

ENERGY ELEMENT	CONNECTION TO WATER QUANTITY	CONNECTION TO WATER QUALITY
Energy extraction and production		
Oil and gas exploration	Water for drilling, completion and fracturing	Impact on shallow groundwater quality
Oil and gas production	Large volume of produced, impaired water*	Produced water can impact surface and groundwater
Coal and uranium mining	Mining operations can generate large quantities of water	Tailings and drainage can impact surface water
Electric power generation		
Thermo-electric (fossil, biomass, nuclear)	Surface water and groundwater for cooling** and scrubbing	Thermal and air emissions impact surface water and ecology
Hydro-electric	Reservoirs lose large quantities to evaporation	Can impact water temperatures, quality, ecology
Solar PV and wind	None during operation; minimal water use for panel and blade washing	
Refining and processing		
Traditional oil and gas refining	Water needed to refine oil and gas	End use can impact water quality
Biofuels and ethanol	Water for synthesis or steam reforming	Refinery wastewater teatment
Synfuels and hydrogen	Water for synthesis or steam reforming	Wastewater treatment
Energy transportation and storage		
Energy pipelines	Water for hydrostatic testing	Wastewater requires treatment
Coal slurry pipelines	Water for slurry transport; water not returned	Final water is poor quality; requires treatment
Barge transport of energy	River flows and stages impact fuel delivery	Spills or accidents can impact water quality
Oil and gas storage caverns	Slurry mining of caverns requires large quantities of water	Slurry disposal impacts water quality and ecology

*Impaired water may be saline or contain contaminants

**Includes solar and geothermal steam-electric plants

FRACKING. Development of a gas field along the Colorado River. Each well uses hydraulic fracturing techniques, which involve heavy water consumption.

than their future usability. And nowhere in the world has this become more of a focus of attention than in what the Washington-based Woodrow Wilson Center calls the "The Thirsty Triangle" – the energy trade involving Canada, China, and the United States.[3]

A significant, if perhaps disproportionate, amount of attention is being focused on water issues related to the shale revolution in the United States and Canada. Two issues loom large – the adequacy of water supplies, including underground aquifers capable of providing fresh water for hydrofracking; and the integrity of aquifers in the exploitation of shale gas and tight oil and in the disposal of waters used in the fracking processes.

The shale revolution has excited the imaginations of many because of the superabundance of original shale source rock for oil and gas globally, and the huge resources of commercially exploitable tight formations that have become within reach of current exploitation methods due to hydrofracking.

Hydrofracking – or more technically hydraulic fracturing – is a technique that has been used in hydrocarbon exploitation for three-quarters of a century, predominantly in the United States but elsewhere as well. The shale-based natural gas and tight oil formations that have been the targets of hydrofracking contain an abundance of oil and gas, but the molecules are trapped in semi-porous rocks. The use of water under high pressure, containing sands and chemicals that are specifically designed to break open the pores of the rock, enabling them to release their trapped hydrocarbons, lies at the core of fracking. Hydrofracking is based on water containing sands and chemicals, but other forms of fracking are available or in development, including the use of foams.

Hence, the adequacy of the water supply is a critical issue given the fact that somewhere between 3 and 5 million gallons of water per well is required to be effective. The availability of water has been a problem even in Texas, where production of oil from tight formations has now exceeded 1 million barrels per day. It is prevalent as a problem throughout the U.S. Southwest, including resource-abundant Southern California and Arizona, and has also become problematic in the resource-rich grain belts of Minnesota, Nebraska, Iowa, and Illinois, as well as in the eastern seaboard region of the country.

> The availability of water is a problem throughout the U.S. Southwest and has also become problematic in the resource-rich grain belts as well as in the Eastern seaboard region

THE CHINESE EXAMPLE

Nowhere is water adequacy more problematic than in China, which is now reckoned to be potentially the largest holder of technically recoverable shale gas in the world. A recent E.I.A. study ranked China as #1 with 1,115 trillion cubic feet of shale gas reserves, and the U.S. as #4 with 665 tcf, after Argentina and Algeria.[4] But adequate water remains elusive and serves as a massive obstacle for development in China, given today's technology.

But beyond the adequacy of water lurk other issues. Much attention has been placed on best practices to assure the integrity of aquifers, which lie at levels normal well above – by several kilometers – the levels where fracking takes place. These include steel-cased pipe wrapped in cement to prevent leakage of fracking fluids or hydrocarbons flowing through underground water systems. Best practices also limit or prevent the disposal of waste fluids beneath the earth's surface. But still, wastewater is generated, above-ground leachate run-off needs to be controlled, and water needs to be recycled for re-use or other uses. Until new technologies are developed, as much as 20 percent of the water used might be lost.

Thus far, hydrocarbon exploitation has spurred on technological developments that were not believed attainable just a decade ago. Undoubtedly the pace of technological innovation will continue to accelerate. But there remain unknowns about the interdependent relationships between energy and water, with greater needs to use water to develop adequate oil and gas resources, and greater needs to use energy to tap into water resources, to create new resources from salt water and to protect and recycle water supplies.

1 *Energy Demands on Water Resources*, Report to Congress on the Interdependency of Energy and Water, U.S. Department of Energy, December 2006, p.17.

2 Takeaways from Citi's most recent conference can be found at "Citi Water Investment Conference Takeaways; All-Star Panels Plunge into the Next Big Things in Water." Deane M. Drey et al., Citi Equities Research, July 1, 2013.

3 See "The Thirsty Triangle: The Water Footprint of Energy Trade Between China, Canada, and the United States," a conference at the Woodrow Wilson Center on May 3, 2013, with proceedings available at www.wilsoncenter.org/event/the-thirsty-triangle.

4 See Energy Information Administration, "Shale Oil and Shale Gas Resources Are Globally Abundant," (June 10, 2013).

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Conflicts/Water will be the first trigger, many specialists say

More dangerous than oil?

Inadequate water resources will be a destabilizing factor. Technologies and projects to deal with this problem already exist, but political initiative has been insufficient at best, and mostly non-existent

by MOISÉS NAÍM

Oil was the reason behind many of the armed conflicts that erupted in the 20th Century. Will water replace oil as a source of conflict in this century? Yes. According to top conflict and security specialists, water will be the next major driver of international conflict. Pressure from multiple factors is reducing access to clean and reliable sources of water. And, although technological fixes are known and awareness of the problem is growing, the lack of needed political will and international cooperation are contributing to the deterioration of water supplies across the planet.

The security threat is recognized by prominent global leaders. The Director of National Intelligence of the United States reports: "During the next 10 years, many countries im-

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portant to the United States will experience water problems—shortages, poor water quality, or floods—that will risk instability and state failure, increase regional tensions, and distract them from working with the United States on important U.S. policy objectives. Between now and 2040, fresh water availability will not keep up with demand absent more effective management of water resources. Water problems will hinder the ability of key countries to produce food and generate energy, posing a risk to global food markets and hobbling economic growth. As a result of demographic and economic development pressures, North Africa, the Middle East, and South Asia will face major challenges coping with water problems. The lack of adequate water will be a destabilizing factor in some countries because they do not have the financial resources or technical ability to solve their internal water problems. In addition, some states are further stressed by a heavy dependency on river water controlled by upstream nations with unresolved water-sharing issues. Wealthier developing countries probably will experience increasing water-related social disruptions…"[1]

"The future political impact of water scarcity may be devastating," said former Canadian Prime Minister Jean Chrétien. "Using water the way we have in the past simply will not sustain humanity in future." Chretien co-chaired a report on the water crisis issued by InterAction Council (IAC), a group of 40 prominent former government leaders and heads of state. The IAC called on the United Nations Security Council to recognize water as "one of the top security concerns facing the global community."

THE PEAK

Lester Brown, who leads the Earth Policy Institute in Washington, D.C., reports that 18 countries which are home to half of the world's population, including China, India and the U.S., are now over-pumping their aquifers. Some of them, such as Iraq and Yemen, are already in a critical situation of water availability. Echoing the once-common references to "Peak Oil," Brown refers to "Peak Water" to emphasize that some of the water used is not being replenished. From this perspective, the world is consuming water at a faster speed than the water that becomes available through natural cycles.

There are three surprises about the world's water crisis: the first is how grave it is and therefore how urgent it is to do something about it. The second is the number of good ideas, projects, technologies, public policy reforms and international initiatives that are currently available to act on it. The third, and the most ominous surprise, is how little is actually being done to tackle this problem.

WHAT IS CAUSING THE CRISIS?

Oil is one factor of the water crises and their potential for conflict. The recent boom in shale gas and massive oil production contribute to the global water crisis in at least two ways: first, through the increasing competition between producers of shale gas and farmers for limited water, and second, via their impact on global warming and its effects on climate change. But fossil fuel production and consumption is neither the only nor the most significant driver of the world's water crisis. There are at least four other factors that are also contributing to the problem: demographics,

NEVER BEEN SO HIGH

In spite of the economic crisis, per-capita income and levels of consumption are now the highest in human history. The rapid growth of the middle class in countries such as Turkey, Mexico, Indonesia and Mongolia allows more people to have diets and lifestyles that are water-rich.

prosperity, climate change and new sources of demand for water.

DEMOGRAPHICS

Probably the most important force behind the current and future water shortages is population growth. The demand for water is a directly related to the number of humans on earth. And that demand is not just a function of how much water each one of the 7 billion people consumes every day but also by what else they do that either reduces the supply of water or boosts the demand. For example, cutting trees and the rapid desertification of forests reduces the supply of water, whereas using more ethanol to fuel cars requires water for biofuel production.

The numbers that illustrate the water situation are staggering. In Pakistan, for example, one third of the population already lacks access to safe drinking water, and its population of 180 million will grow to about 230 million by 2050. Shifting demographics due to the internal migration spurred by violence and the war against the Taliban further complicates that country's water shortage situation. Pakistan barely has a 30-day supply of water in its reservoirs – far below the almost three years of stored water that are recommended for countries with a similar climate.

While Pakistan may be an extreme example, in many other countries, water crises resulting from rapid population growth and the displacement of large quantities of people as a result of man-made disasters or climatic accidents are becoming increasingly common.

PROSPERITY

Despite the economic crisis that has affected much of the world since 2008, per capita incomes and consumption levels are now higher than ever before in human history. More prosperous humans consume more water as their disposable incomes allow for more water-intensive lifestyles and dietary patterns. The fast-growing middle class in countries like Turkey, Mexico, Indonesia or Mongolia consumes more water. Worldwide, meat consumption has soared, and producing one pound of meat requires ten times more water than the production of vegetables with equivalent calories and proteins. Professor Brahma Chellaney has noted that the obesity pandemic that is now affecting the world also adds to our water problems. "The issue thus is not just about how many mouths there are to feed, but also how much excess body fat there is on the planet." He cites a study that found that if the rest of the world had the same average body mass index as the U.S., this would be the equivalent of adding almost one billion people to the global population, greatly exacerbating water stress.

CLIMATE CHANGE

Writing about a recent visit to Syria, New York Times columnist Tom Friedman reported: "between 2006 and 2011, some 60 percent of Syria's land mass was ravaged by the drought and, with the water table already too low and river irrigation shrunken, it wiped out the livelihoods of 800,000 Syrian farmers and herders." The World Meteorological Organization estimates that water availability has decreased up to 30 percent in arid countries, mostly due to the impact of carbon dioxide emissions derived from fossil fuels. Warmer temperatures, altered precipitation patterns, and more frequent and longer droughts are already reducing the amount of water in lakes, rivers, and streams, as well as the amount of water that seeps into the earth to replenish ground water. And while this is a global phenomenon, some countries are far more vulnerable than others. According to Iran's Minister of Agriculture, Issa Kalantari, the country could become inhabitable in the next 30 years if the water issue is not addressed. Iran has no important watersheds and already depends on fossil and imported water. Again, Iran is not alone in this predicament: frequent drought and retreating glaciers have diminished water availability in La Paz, Bolivia's capital, while Lake Titicaca is at its lowest level since 1949. The Nile River is under stress, and rights to its waters are a source of conflict between Egypt and Ethiopia.

> The world's water crisis is grave and urgent; there are good projects and technologies available for it; but very little is actually being done to tackle this problem

NEW SOURCES OF DEMAND FOR WATER

A recent study by Rice University concluded: "It takes 50 gallons of water to grow enough Nebraska corn to produce the amount of ethanol needed to drive one mile" – or, put in different terms, the production of one liter of corn ethanol requires between 350 and 1400 liters of water from irrigation."

In Texas, competition for water between farmers along the Brazos River and Dow Chemical had to go to the courts. In seven states of the U.S., shale gas producers compete with other users for decreasing water resources, due to persistent drought. In China the town of Daliuta in the province of Shaanxi is the center of a conflict between coal mining and the needs of the community for its limited water resources. Coal and electricity generation now use almost 20 percent of China's water resources, and the United Nations estimates that 80 percent of coal production in China is centered in areas where water supplies are either stressed or in absolute scarcity.

WHAT TO DO?

The world can do more about the water crisis it faces by applying technological solutions that already exist and investing more in creating new, better ones. It can also do more by improving the management of its water resources. It is doing far less than what its needed and – more worryingly – less than what it can immediately do with the knowledge, technologies and institutions now available.

Understanding why the world is passively watching this major crisis unfold without reacting more effectively is a puzzle that needs to be urgently solved. The reality of the problem is clear. The need for action and international cooperation to avoid water shortages and conflicts is also very clear. Unfortunately, the political incentives to come up with initiatives that push global public opinion and world leaders out of complacency are sorely lacking.

This needs to change. Responding to the world's water crisis is probably one of the most pressing problems humanity will face in the 21st century.

1. *Global Water Security*, Intelligence Community Assessment by the Office of the Director of National Intelligence.

Moisés Naím, a member of the editorial board of *Oil*, is a scholar at the Carnegie Endowment in Washington and the author of *The End of Power: From Boardrooms to Battlefields and Churches to States, Why Being in Charge isn't What it Used to Be* (New York, Basic Books, 2013).

Middle East/Water has more to do with cooperation than with conflict

No water wars on the horizon

Water – unlike oil – is a fairly abundant renewable resource that is relatively well distributed. Water demand from industrialized societies is also reasonably elastic, and water does not produce revenues that are in any way comparable to those derived from "black gold"

by JAN SELBY

Since the end of the Cold War, the environment – and water in particular – has become a major security concern. "Water wars," it has been claimed, "are unfortunately likely to be more and more common in the future," to the extent that "water security will soon rank with military security in the war rooms of defense ministries." The U.N. Secretary General has claimed that "competition between communities and countries for scarce resources, especially water, is increasing, exacerbating old dilemmas and creating new ones," while a recent US Intelligence Community Assessment forecasts that "during the next ten years, water problems will contribute to instability in states important to US interests."

Indeed, some claim that water is the "new oil." A World Bank Vice-President has speculated that while many of the wars of the last century were about oil, the wars of the twenty-first century will be over water. "Nations go to war over oil, but there are substitutes for oil. How much more intractable might be wars that are fought over water, an ever-scarcer commodity for which there is no substitute?"

This is a frightening prospect indeed – or at least it would be if there were more substance to this speculation. In reality, water is not the "new oil," and water wars are not on the horizon. To see why, we need to reflect on why oil has been such a persistent cause of conflict, especially in the main oil-producing region, the Middle East, before considering whether anything similar applies in the case of water.

OIL CURSE

Oil is a persistent cause of political conflict and violence in the contemporary Middle East. All conflicts have multiple causes, of course, but for the Middle East's oil-producing states, oil has been the common denominator behind most of them. Oil sales have provided spectacular windfalls for oil producer "rentier states," enabling them to pursue state-led development, to build up large internal security apparatuses and patronage systems, and to resist calls for democratization. Indeed, all across the region – from Iran to Saudi Arabia to Algeria – oil has been associated with corruption, authoritarianism and internal repression.

International consequences have been no less pronounced, most notably in

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the Gulf. There, not only are oil fields a focus of territorial ambitions and insecurities; in addition, patterns of conflict have been heavily affected by fluctuations in oil prices, and oil revenues have provided the major financial resources for external aggression and the promotion of radical Islamist ideologies. The 1980-88 Iran-Iraq war – the longest conventional inter-state war since 1945 – was only made possible by oil. Iraq's subsequent 1990 invasion of Kuwait was likewise heavily influenced by oil, specifically by Iraq's indebtedness to Kuwait within the context of declining oil prices, and by its territorial claims on the Rumaila oilfield. The regional dissemination of Salafi ideologies by Saudi Arabia and the Gulf Emirates, and their funding of radical Islamist movements and regimes from Pakistan and Afghanistan to Yemen, Somalia and Sudan, would likewise have been impossible without oil wealth.

Oil is also the central factor in international, especially U.S., involvement in the region. The Gulf has become the key arena outside the Korean peninsula for U.S. military forces. From Iran and Iraq to Libya, oil producer states have become a recurring target of Western-led economic sanctions and military interventions. In other cases, oil explains why these same Western states have been willing to support authoritarian regimes like Saudi Arabia and the Emirates, even when they have been officially committed to democracy promotion.

THE CAUSES OF CONFLICT

What accounts for these intimate links between oil and conflict? At →

Oil tensions in the Gulf

The **IRAN-IRAQ WAR** (1980-88) – the longest conventional war between two countries since 1945 – was only possible because of oil. In financial terms, the direct cost of the conflict came to $200 billion, plus $1,000 billion in indirect costs.

IRAQ'S 1990 INVASION OF KUWAIT was caused in large part by Iraq's debt to Kuwait at a time of falling crude oil prices, as well as Iraq's territorial claims over the Rumaila oil field.

The Gulf has became the **CHIEF ARENA FOR U.S. MILITARY FORCES** outside the Korean peninsula. Oil is the main driver of international involvement in the region, especially for the United States.

The regional **SPREADING OF SALAFI IDEOLOGIES** nurtured by Saudi Arabia and the Gulf Emirates, and the financing of regimes and movements inspired by Islamic fundamentalism (from Pakistan to Afghanistan, Yemen, Somalia, and Sudan), would not have been possible without oil wealth.

heart, there are four reasons. First and most important is the incredible dependency of modern mass consumer societies and the global economy on oil, a degree of dependency which is "locked in" to modern infrastructures and technologies (especially our cars), and which renders oil demand highly inelastic, at least over the short term. Second, oil is distributed extremely unevenly, with over 50 percent of proven oil reserves being located in the Middle East – this necessarily making oil a heavily internationally-traded commodity, and making the major oil consumer regions of Europe, East Asia and, to a lesser extent North America, highly dependent on oil imports. Third, oil exploitation and supply are relatively complicated, requiring significant capital and technological investment, and vertical integration; as a result, the oil industry is characterized by a high degree of concentration, even monopoly. In addition, oil is a finite resource (though quite how much oil exists, or could be exploited, is a matter for debate). Together these factors make oil both a strategically crucial resource for producer and consumer states alike, and a source of huge revenues for a range of local and international elites – in turn feeding into the patterns of political and violent conflict discussed above.

THE CHARACTERISTICS OF WATER

Does anything similar apply in the case of water? The answer has to be a resounding no. To start with, while water is of course biologically indispensable, the paradoxical truth is that oil is in other respects more important for modern economically-developed societies than water. By way of illustration, in 1991 Israel experienced a significant drought to which it responded by reducing total water consumption by a third – with negligible impacts on economic growth or stability (indeed, this was a boom period in Israel). By contrast an equivalent cut in oil supplies would have had far-reaching social and economic consequences. Within industrialized or post-industrial societies, water demand is much more elastic than demand for oil, at least over the short term.

Secondly – and here the differences with oil are most keen – water is a renewable, relatively plentiful, and relatively well-distributed resource. The total volume of world water resources is on the order of 1,385 million square kilometers, and while only 2.5 percent of this is fresh water, it is nonetheless the case that fresh water can be created from saline water as well as reused and recycled ad infinitum. Wastewater is now routine-

HALABIYE, SYRIA
The River Euphrates represents an important strategic resource and a delicate foreign-policy issue for the three countries it passes through: Turkey, Syria and Iraq.

ly recycled for agricultural and even human consumption. Sea water is very often desalinated (including in the Gulf states, where oil helps power the process; and in Israel, which has the economic might to desalinate whatever it needs). And states in water-scarce parts of the world increasingly rely on "virtual water" imported in the form of food staples (indeed, Israel, Egypt, and many other Middle Eastern states are as dependent on rain falling over the American prairies as they are on that from the Nile or Jordan Rivers). There are multiple ways in which states and societies can adapt to water scarcity. Some undoubtedly fail to adapt, or are prevented from adapting – but the primary reasons for this are economic and political, not the natural distribution of resources.

Third, water does not and could not conceivably generate equivalent revenues to oil. It is sometimes suggested that water might become a new "blue gold," but this is misleading. The extraordinary revenues accrued from oil are products of the industry's complexity and concentration, combined with the economic and infrastructural dependency of our "hydro-carbon societies" and the international oil trade. But none of these factors apply in the case of water. Most of the world's water supplies are accessed and consumed within the boundaries of the same state, limiting the capacity of local elites and providers to generate windfall profits from water supplies. Indeed, water is arguably of declining, not rising, economic and political importance. Most water is still used for agricultural production, but agriculture accounts for ever-smaller proportions of most countries' national products, exports and employment. Unlike oil, water is not an important source of economic or political power.

A REGIONAL STRATEGIC RESOURCE

It follows from this that water is not a strategic resource to the same extent as oil. For some states water is, of course, an important foreign policy concern, especially in circumstances where these states are dependent on large trans-boundary rivers flowing through arid regions (Egypt on the Nile, and Syria and Iraq on the Tigris-Euphrates). But such cases are exceptions to the general rule. Moreover, water is a strategic good only on a regional level, never more widely. While the U.S. has direct interests in the stability of Middle Eastern oil production and supplies, it has no equivalent interest in relation to water.

> Water may become an important source of violence in peripheral agricultural regions, but these conflicts are likely to be small-scale and localized rather than inter-state

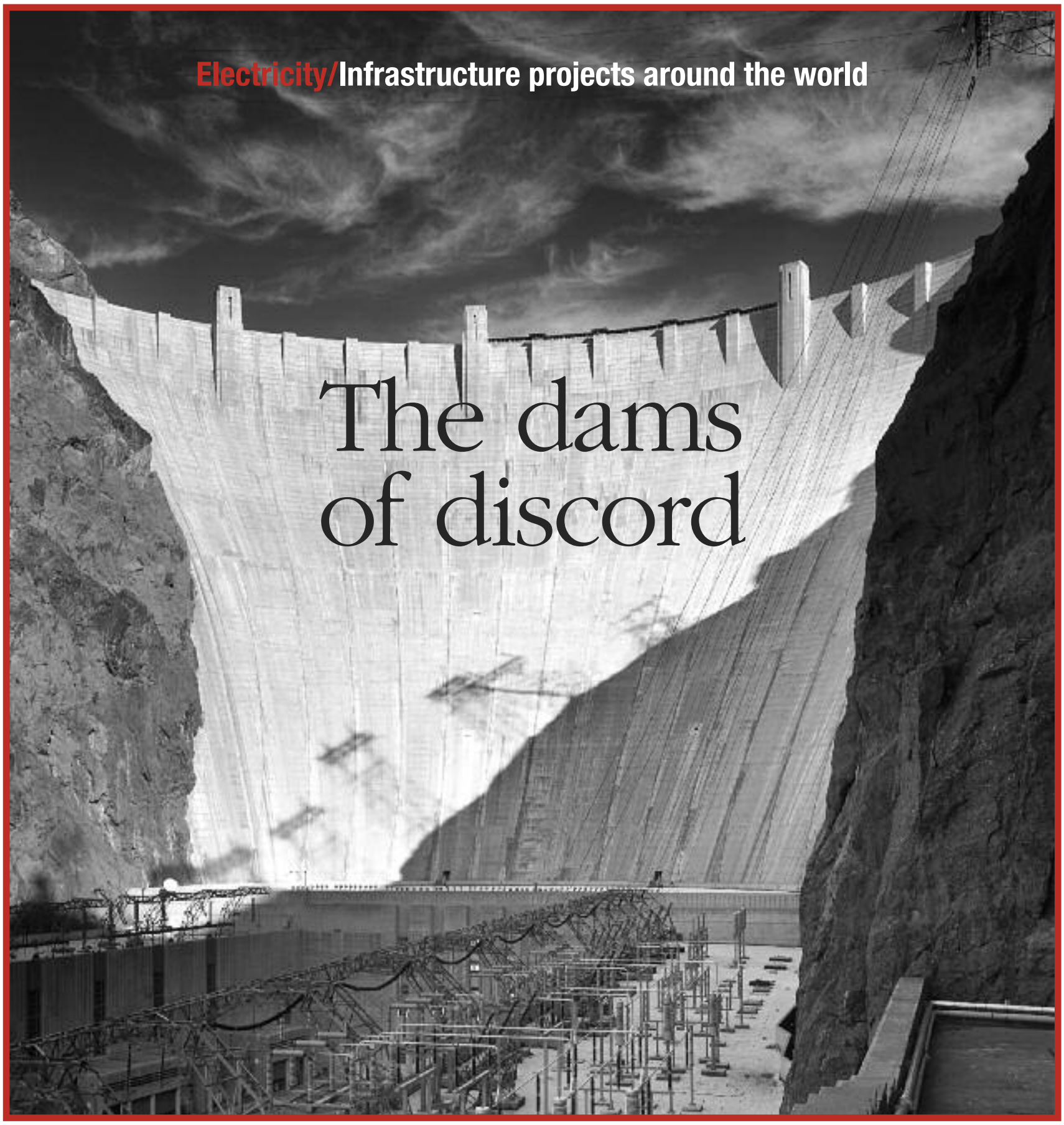
Given these fundamental differences, it should be no surprise that there exists very little evidence of water causing or even contributing to armed conflict. Even in the most water-scarce regions of the Middle East, water is simply not important enough, as a source of revenues or security, for state elites to warrant going to war over it. Water is sometimes a subject of hostile rhetoric – as with Egyptian President Morsi's pre-coup threats against Ethiopia over the construction of its Grand Renaissance Dam – but there is little evidence of such rhetoric being followed through. The 1967 Arab-Israeli war, sometimes described as a "water war," was nothing of the sort. Equally, the water dimensions of the Israeli-Palestinian conflict, often described as intractable, could fade away quickly if the broader conflict were resolved: in strictly economic terms, Israel could quite feasibly grant the Palestinians a much larger share of shared water resources. The only recorded Middle Eastern water war occurred 4500 years ago, between two Mesopotamian city-states. None of this exactly suggests that water is on the verge of becoming the "new oil."

COOPERATION

Indeed, the current academic consensus is that water is more associated with cooperation than conflict. This does not mean that water is a subject of harmony. Trans-boundary water "cooperation" can obscure and even perpetuate stark inequalities of water supply. Moreover, localized violence over access to springs, pastures or pipelines occurs in many areas of the Middle East and beyond, especially within peripheral rural areas. Sometimes this is violence is inter-communal, but more often it involves states. In central Sudan, Khartoum-backed militias have repeatedly employed violence to displace people from areas of rain-fed agricultural land that have been marked out for agro-industrial development. On a very different scale, in the West Bank the Israeli military authorities continue to restrict Palestinian water development and access to supplies in areas marked out for strategic and settlement purposes. But such cases hardly amount to evidence of "water wars."

It seems unlikely that this will change in any significant way. Water may become an increasingly important site or source of violence in peripheral agricultural regions, but these conflicts are likely to be small-scale and localized rather than inter-state, and quite different from those associated with oil. Indeed, given our ever-increasing oil dependency, combined with pressures on remaining reserves, the major source of conflict in the Middle East is likely to remain disturbingly familiar. The main "new" source of conflict will probably be the same as the old one: oil.

On www.abo.net, read further articles about the same issue by Peter Brabeck-Lethmate, Antonio Galdo, Marco De Martino.



The dams of discord

The exploitation of cross-border water resources has historically been a cause of international tensions. Access to fresh water in Africa, Central Asia, the Middle East and Latin America is a major bone of contention

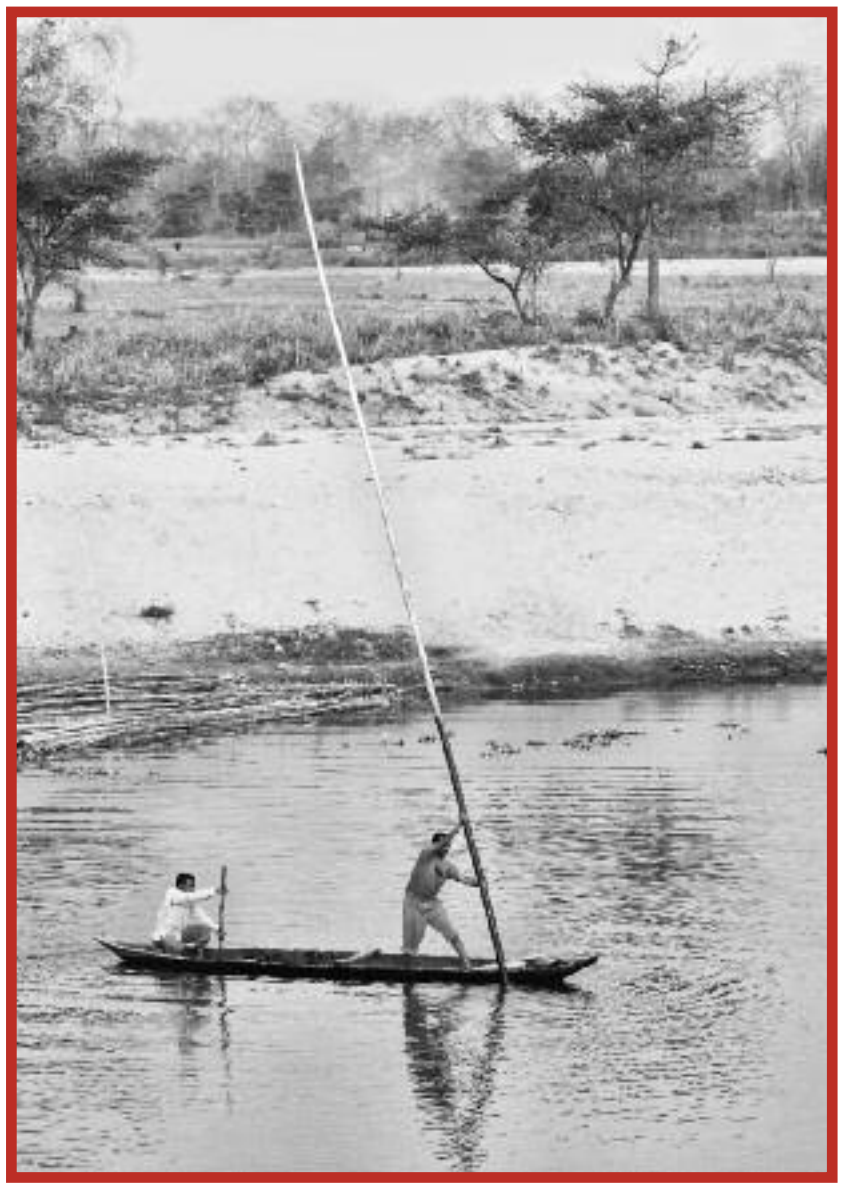
by NICOLÒ SARTORI

In developing countries, major infrastructural works – such as dams, reservoirs and canals – are not only essential in the management of irrigation water and agriculture, but also play an increasingly important role in the generation of electricity. However, the exploitation of cross-border water resources has historically been a source of international tension. Access to fresh water is a major cause of conflict and geopolitical instability in Africa, Central Asia, the Middle East and Latin America. Now these tendencies could become even more acute: one issue is unchecked economic competition between developing countries, which require ready access to abundant water resources if they are to maintain current growth rates. Much depends on another issue, which is action by

the World Bank, which recently launched a funding campaign for large-scale projects in the sector, with a view to boosting investment in major hydroelectric plants over the coming years.

THE IMPACT ON ELECTRICITY GENERATION

According to figures from International Rivers, there are more than 40,000 large dams (over 15 m in height) around the world, with more than half of these located in China. The Asian giant also plays a key role in worldwide development of the sector. Beijing is the single largest international investor in dams and water plants and is also funding more than 280 projects currently being planned or built outside China. Other than China, the developing countries that have invested most in the sector over the last decade are Iran, Turkey, India and Brazil. Counting the total number of initiatives around the world is a complex task. Around 1,600 large dams are currently being built worldwide, with an annual turnover of around $50 billion. Somewhere in the region of 500 projects have been proposed along the banks of the Ganges, between India and Bangladesh, while more than 100 are being planned or built along the Amazon and about ten are at the application stage in the Mekong Basin. More than half of all large dams are built exclusively or primarily for agricultural irrigation. They supply water to about 30-40 percent of the irrigated areas of the world. Figures from the International Commission on Large Dams (ICOLD) tell us that the world's top five dams by irrigation capacity are all located in Turkey and can supply water to an area of 350,000 km^2. Even though only slightly more than 15 percent of dams are used to feed hydroelectric power stations, they still have a significant impact on global electricity generation capacity. Indeed, hydroelectric power stations account for more than a fifth of all electricity generated worldwide. In Brazil, for example, 80 percent of electricity demand is met by hydroelectric power stations, while in 24 countries this figure exceeds 90 percent. The Three Gorges Dam on the Yangtze River in Hubei Province, China, feeds the largest hydroelectric power station in the world, with an installed capacity of 22,500 MW. Fully operational since 2012, the Chinese super-plant has now overtaken the Itaipu Dam on the Paraná River at the border between Paraguay and Brazil, which alone supplies a fifth of total Brazilian electricity consumption.



DISPUTES RE-AWAKENED BY MAJOR PROJECTS

In recent months, the approval of major projects for the management and exploitation of cross-border water resources has re-awoken latent tensions in almost every continent. Aside from concerns over the environmental impact of these large-scale projects and the fate of local populations forced to leave their homes and give way to the new infrastructure, the biggest contributor to tension between riparian countries is the issue of fair distribution of resources. In Africa, Ethiopia's decision to build the Grand Ethiopian Renaissance Dam on the Blue Nile immediately met strong opposition from the Egyptian government. Some quarters of the Egyptian parliament even voiced fears over the (unlikely) possibility of military action to settle the issue. Egypt claims that building the dam will significantly reduce water resources downstream, which would harm the agricultural sector as well as Egypt's own power-generation capacity. The Ethiopian government, which has the political support of the signatories to the Nile Cooperative Framework Agreement (Burundi, Kenya, Rwanda, Tanzania and Uganda) and has received the approval of the other downstream country, Sudan, has categorically rejected the claims. Despite diplomatic talks and Ethiopia's attempt to reassure Egypt that the water will be used not for irrigation, but only to generate electricity (and therefore will be put back into circulation), the question remains unresolved. In Central Asia, the disputes center on the Rogun Dam in Tajikistan and the Kambarata Dam in Kyrgyzstan. Both countries had two main goals in mind when they launched the projects: to reduce the incidence of energy imports from regional producers (Kazakhstan and Uzbekistan) on their already teetering national budgets; and to bolster their own economies by increasing electricity exports to Afghanistan and Pakistan through the Central Asia South Asia Regional Electricity Trade Project (CASA-1000). The plans immediately drew reactions from Kazakhstan and, above all, from Uzbekistan. Calling attention not only to access to water resources in downstream countries, but also to the risk of earthquakes throughout the region, Uzbekistan's President Islam Karimov has appealed vociferously for the international community to block the two projects. In reality, while it is true that the two dams would change the flows of the Amu Darya and the Syr Darya, the Uzbek government is more concerned about competing with Tajikistan and Kyrgyzstan over the electricity market in Afghanistan (and potentially in Pakistan), where demand is currently satisfied by electricity from Uzbekenergo. One of the most controversial projects in Southeast Asia is the Xayaburi Dam, in the province of the same name in northern Laos. If built, the dam would cause a major redistribution of water resources, to the detriment of downstream countries including Cambodia and Vietnam, and would set a dangerous precedent. The Laos-Thailand initiative actually violates the 1995 Mekong Agreement, which requires the four member states of the Mekong River Commission (MRC) to reach agreement over new infrastructural projects on the river. In 2012, objections from Cambodia and Vietnam led to an agreement to suspend construction of the dam until independent studies showed the project's real impact on river fauna migratory patterns and, in general, on food security in the region. Regardless of the formal agreement, the Laos government – emboldened by the political support of its Chinese benefactors – authorized the Thai company CH. Karnchang to proceed with the works amid protests from Vietnam and Cambodia and the concerns of the international community.

> The World Bank has financed more than 600 large dams since 1945, with the (often ignored) aim of providing Third World countries with low-cost electricity

The construction of a series of dams in the Kashmir region has also sparked a further deterioration in bilateral relations between India and Pakistan, which were already tense. According to a recent ruling from the Permanent Court of Arbitration (PCA), the Kishanganga Dam can be added to the nine existing projects launched by New Delhi along the Indo, the Chenab and their tributaries in the Kashmir area. The Kishanganga Dam is located on the Neelum River, upstream from the →

Danger! High Tension

KAMBARATA-1 DAM AND POWER PLANT [KYRGYZSTAN]

The Kambaratinsk (also known as Kambar-Ati-1 or Kambarata-1) is the sixth planned dam on the **Naryn River**, a tributary of the Syr Darya River, in the Kambar Region of Kyrgyzstan. Once completed it will be one of the largest dams in the world, standing approximately 275 m high and holding around **370 million m³** of rock and earth. The hydroelectric plant at the base of the dam will generate **2,000 MW of electricity**. The Kambarata-2 hydroelectric plant is located on the same river. It contains three individual turbines with a nominal output of around 120 MW each, delivering up to **360 MW of power**. The first generator became operational in November 2010.

ROGUN DAM [TAJIKISTAN]

Construction of the Rogun Dam began in 1976, but work on the structure at the cascade of the **Vakhsh River** remains unfinished because of its complexity and the collapse of the USSR. If and when it is finished, Rogun – which lies in the Amu Darya basin in Tajikistan – will be a truly enormous dam; at 335 m tall, it would become **the highest in the world**. The project would also create a reservoir 70 km long, which would take between eight and 10 years to fill. In energy terms, Rogun would be enormously significant for Tajikistan, generating **3,600 MW of hydroelectric energy** (roughly the equivalent of three nuclear reactors). This would almost double the country's current energy output, 95 percent of which is based on hydroelectric power from plants built during the Soviet era.

GRAND ETHIOPIAN RENAISSANCE DAM [ETHIOPIA]

Formerly known as the Millennium Dam, the Grand Ethiopian Renaissance Dam is located **on the River Nile** near Guba, in the Benshangul-Gumuz Region. Once completed, the dam will be **145 m high** and 1,800 m long. The complex comprises 15 turbines (10 in the left-hand power station, five in the right), each capable of generating **350 MW of electricity**. Overall, the dam will have a maximum capacity of around **5,250 MW** – three times the current amount of hydroelectric energy produced across Ethiopia (currently 1,885.8 MW, generated by 12 dams).

Neelum-Jhelum Dam, devised by Pakistan's Water and Power Development Authority (WAPDA) to supply a 1,000 MW hydroelectric plant. In 2010, the Pakistani government applied to the PCA under the Indus Waters Treaty of 1960 because it was concerned that the Kishanganga Dam would hinder the generation capacity of its own plant. Even though the PCA's response confirmed the legality of India's plans and ordered for rules to be set during 2013 on how much water India can use, it seems that Pakistan's resentment over the initiative is unlikely to be quelled.

Lastly, China's endeavors in the sector could not fail to generate friction with neighboring countries. In particular, the Indian government has been taking a keen interest in the level of self-restraint Beijing will exercise in the projects it has commissioned on Tibet's Yarlung River. The issue concerns the Jiexu, Zangmu and Jiacha dams, all of which are located within 25 km of each other in an area not far from the border between the two countries. Even though the original plans do not – officially – involve the diversion and storage of water from the Yarlung River (known as the Brahmaputra in India and Bangladesh), the governments of the Indian states of Arunachal Pradesh and Assam suspect that the finished articles will actually have a major impact on their water supplies. Both parties are currently in a consultation phase, with Beijing seeking to limit the dissemination of public information on the initiative and the local authorities in the two Indian states aiming to convince New Delhi to protect their interests in its dealings with China.

Beijing's increasing difficulties in relationships with its neighbors are confirmed by the suspension of construction work on the controversial Myitsone Dam in northern Burma (Myanmar). In this case, it is not a question of a clash between riverside countries for the management of cross-border waters, but of the Burmese government pulling out of the mega-project funded by China to guarantee clean electricity supplies to the southern region of Yunnan. In September 2011, dogged by protests from the indigenous population of Kachin State, Burma's central government ordered a temporary halt to construction of the dam, which had been allocated an investment of around $20 billion. However, Burma's decision was not motivated solely by environmental concerns raised by the local population. In fact, it was seen as an attempt to reduce Beijing's influence on the country's politics and economy, especially as the Burmese government has embarked on a path of openness and cooperation with international partners including the United States and the European Union. Burma's decision has not, in any case, generated any particular

THREE GORGES DAM [CHINA]

The Three Gorges Dam (or Three Gorges Project) takes its name from the three gorges crossed by the Yangtze River: the Qutang, the Wuxia and the Xiling. The dam sits on the **Yangtze** in Hubei Province, China, and in terms of installed capacity is the largest hydroelectric power station ever built. **Completed in 2006**, it is part of an even larger complex that was finalized in 2009. The reservoir covers more than 10,000 km^2 and has a maximum capacity of **39 billion m^3 of water**. The plant has an estimated annual output of around 305,000 TJ, or 84.7 TWh per year – equivalent to around three percent of China's total electricity usage.

XAYABURI DAM [LAOS]

Begun in 2012, the Xayaburi Dam lies on the Lower **Mekong River**, about 30 km east of the town of Xayaburi (Sainyabuli) in northern Laos. The dam is located 770 km downstream from Jinhong, the last of the seven Chinese dams on the Mekong, four of which have already been built; the remaining three are in the planning stages. Upon completion in 2019, the Xayaburi Dam will be **820 m long** and 32.6 m high. With a catchment area of 272 km^2, the dam will create a reservoir with a capacity of approximately 1.3 km^3 and a surface area of 49 km^2. The power station will contain eight Kaplan-type turbines (seven at 175 MW and one at 60 MW). Its total installed capacity will be **1,285 MW**, with a total annual energy output of **7,406 GWh**.

MYITSONE DAM [BURMA]

The Myitsone Dam is a large hydroelectric dam currently under construction on the **Irawaddy River** in Burma (Myanmar). Upon completion (expected in 2017) it will be the fifteenth-largest hydroelectric power station in the world. The dam is intended to be 1,310 m long and **139.6 m high**. It is expected to supply between 3,600 and **6,000 MW of electricity**, mainly for use in the city of Yunnan, China.

Source: International Rivers, MrcMekong.org

resentment in China. It will only be possible to assess its impact on bilateral relations between the two countries when the dam's fate is finally decided, in 2015.

FUNDING FROM THE WORLD BANK

As part of an effort to provide electricity to the more than 1.6 billion people who still live without power, the World Bank has recently launched a campaign to support the construction of new, large-scale dams in Africa, the Indian Subcontinent and Southeast Asia. This approach, in vogue since the 1950s, had been abandoned for a couple of decades because of the social and environmental risks linked to such massive projects. In fact, the World Bank has financed the construction of more than 600 large dams since World War Two, with the (often ignored) aim of providing Third World countries with the low-cost electricity needed to drive economic growth and social progress. The main initiatives included enormous (and controversial) projects such as the Kariba Dam on the Zambesi River between Zimbabwe and Zambia, or the Akosombo Dam in Ghana. The hiatus in World Bank initiatives lasted nearly a decade, from the early 1990s to the first years of the new millennium. While the bank's renewed involvement in 2003 initially concentrated on small and medium-sized projects, in the last couple of years it seems that its staff have once again begun to take an interest in mega-structures. One of the projects that the World Bank has supported since 2011 is the Grand Inga Dam, in the Democratic Republic of Congo. The hydroelectric power station will have an installed capacity of 44,000 MW – nearly double that of the Three Gorges Dam – while its building costs are expected to be around $80 billion. In addition, the World Bank is set to finance two huge projects on the Zambesi: the Batoka Dam devised by the governments of Zambia and Zimbabwe; and the Mphanda Nkuwa, which has been put forward by Mozambique.

Thanks to the financial support and legitimacy offered by the World Bank, a boom in investment in large hydroelectric projects is expected over the coming years.

According to the organization's president, Jim Yong Kim, the World Bank's renewed focus on the hydroelectric sector should be seen as an attempt to tackle two issues simultaneously: poverty and CO_2 emissions caused by using coal and biomass to generate electricity. Indeed, the constant growth in electricity demand among developing countries calls for a reflection on the energy generation mix they employ, if we are to tackle the serious environmental risks linked to global warming. At the same time, greater use of hydroelectric power can mitigate the additional costs and risks related to the volatility of hydrocarbon prices and of imported supplies, thereby cutting the amount countries spend on energy imports.

However, the World Bank's support of these major infrastructural projects has attracted many criticisms – and not only from environmentalist groups. Above all, the World Bank has been accused of dogmatism and failing to heed the lessons of past mistakes, both in terms of financial sustainability and in terms of socio-economic and environmental costs.

In terms of possible alternative approaches, the priority is to develop sustainable models that are up to speed with newly available technologies. Therefore, there is a feeling that we should turn to smaller infrastructure, based on less invasive technologies (both for humans and the environment) such as solar and wind power, which can provide clean, low-cost energy both for industry and for consumers.

A less rigid approach to these mega-projects would not only avoid threatening the fragile social and environmental balance that exists in many developing countries, but would also make a significant contribution to reducing the number of disputes between riparian countries over the management of water flows. ■

Nicolò Sartori is a researcher in the Security and Defense Department at the Istituto Affari Internazionali [Institute of Foreign Affairs] in Rome, with a special focus on the evolution of technologies characteristic of the energy industry.

Case study/Disputes over the dam on the Blue Nile

Ethiopia's "Grand Renaissance

The Ethiopian government has launched a mammoth project that threatens to destabilize the fragile understanding between Nile riparian countries. Chinese funding also plays a significant role in the crisis

” dream

by FABIO SQUILLANTE
(AGENZIA NOVA)

The Ethiopian government has begun work on “The Grand Ethiopian Renaissance Dam” – an enormous infrastructure project near the border with Sudan that threatens to destabilize the fragile understanding between Nile riparian countries. In early June, Addis Ababa started diverting the course of the Blue Nile in in the Benishangul-Gumuz region, near the border with Sudan and about 500 kilometers north-west of the Ethiopian capital. In order to build the dam, the river’s course has to be temporarily altered. The Ethiopian Renaissance Dam will be the most significant hydroelectric project in Africa’s history: it will measure 1,800 meters long by 170 m wide, have a volume of 10 million m^3 and an installed capacity of 6,000 megawatts, and generate more than 15,000 gigawatts per year. The total cost of the dam comes to $4.7 billion and the tender for the building work has been awarded to Italy’s Salini Costruzioni, on behalf of the Ethiopian Electric Power Corporation.

SUSPICIOUS TIMING

The new dam, which will reach a capacity of 63 billion m^3 of water, will certainly have a major impact on energy for Ethiopia and nearby South Sudan, and could become an important driver of regional development. However, for Egypt and Sudan the situation is more complicated. For Cairo, in particular, the construction of the dam could bring about a significant drop in the amount of river water at its disposal. Indeed, Egypt says that the quantity of water flowing into the country down the Nile could fall by 18 billion m3. Moreover, many analysts think that the fact that Ethiopia unveiled the details of the project in April 2011 – one month after the fall of former Egyptian president Hosni Mubarak – is anything but coincidental. Indeed, experts reckon that Addis Ababa deliberately exploited its neighbor’s moment of weakness to launch a plan that the authorities in Cairo had openly opposed.

The Ethiopian parliament has also given its unanimous backing to a framework agreement on the Nile that would replace the 1929 and 1959 agreements signed during the colonial era. According to Ethiopia, those agreements gave Egypt and Sudan excessive rights over the waters of the world’s longest river. The new Nile Framework Cooperation Agreement was signed on June 20 by six Nile basin countries (South Sudan, Burundi, Kenya, Uganda, Rwanda and Tanzania) but was rejected by Egypt and Sudan (the countries actually on the banks of the Nile). Sudan is more amenable to compromising with Ethiopia over the dam than Egypt, which has taken a more rigid stance.

EGYPT’S POLITICAL BLUNDER

On June 10, deposed president Mohammed Morsi said that “if the Nile diminishes by one drop then our blood is the alternative.” A few days earlier, the Morsi administration had made a major political gaffe over the Renaissance Dam issue, when a meeting called by Morsi to debate the matter was mistakenly broadcast on public television. Pakinam el Sharkawy, one of Morsi’s advisors, “forgot” to tell those present that the debate would be going out live. Then, as the debate got underway, representatives of the Salafist parties said that the dam’s construction represented “a declaration of war on Egypt” and openly called for intelligence services to destabilize the government in Addis Ababa and thus create disorder in Ethiopia.

The broadcast caused a major outcry, including internationally, despite the apologies of Morsi and his ministers. Indeed, Ethiopia is one of the United States’ closest allies in Africa, since the U.S. has looked to Addis Ababa for help with the stabilization of Somalia and the entire Horn of Africa. Tension between Ethiopia and Egypt could therefore have serious repercussions on relations between Washington and Cairo, especially with the current political chaos in Egypt following Morsi’s fall. Ethiopia, meanwhile, could assume a dominant regional role by gaining control of the Nile’s waters. Hydroelectric power and control of floodwater could turn Addis Ababa into a regional exporter of energy, agricultural produce and food. Sudan – which was initially against the project – could also gain from the construction of the dam, because it would provide the country with a secure supply of electricity, more irrigable land and therefore an increased annual harvest. In any case, the general lack – and contradictory nature – of research into the effect of the project on water flows and the environment makes it impossible to form reliable predictions on any significant harm that could be incurred by Egypt and Sudan.

Chinese money has allowed Ethiopia to free itself from the help of international institutions, whose financial support was conditional on compliance with agreements with Egypt

COOPERATION OR CONFLICT?

From a strategic point of view, Ethiopia is giving itself a voice in the governance of the Nile, meaning it could also have an influence on Egyptian politics. In the coming decades, Egypt will have to face up to the water sustainability of its growing population; some estimates put the country’s population at 150 million by 2050.

According to Egypt’s Institute of National Planning, in order to sustain that growth Egypt will need to increase the amount of Nile water currently at its disposal by about 50 percent. Therefore, water will make the two countries increasingly mutually dependent. As such, the relationship between Egypt and Ethiopia looks set to become closer and more important, which could pave the way for either political and strategic cooperation or increased conflict. Lastly, we should not underestimate the role that China could play in the Nile Valley’s “water crisis.” China’s influence in the region is constantly increasing, and the country is in open conflict with European states over agricultural investment in Nile riparian countries. Moreover, the arrival of Chinese money has already allowed Ethiopia to free itself from the help of international institutions, whose financial support for water projects was conditional on compliance with existing agreements, especially with Egypt.

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U.S./Hydropower receives inexplicably little attention

The silent renewable

There are 80,000 dams in the U.S., but only 3 percent of these are used to generate electricity. Ignorance, regulatory red tape and uneven subsidies hamper development of this energy source

As this publication so professionally documents, since the OPEC oil embargoes of 1974 and 1977 the eyes of the world have been on energy generally, carbon fuels more particularly, and petroleum even more particularly. And, since some time in the late 20th century, increased attention has been paid to the long-range impact of carbon fuel consumption on the global climate.

by GARY HART

This attention to climate in turn has led to promotion of clean (non-carbon), renewable energy supplies, especially solar, wind, and even ocean tides. Curiously, however, in the United States, unlike other countries, little attention has been paid to a clean, renewable source known for more than a century. That is hydropower.

A NEGLECTED RESOURCE

Large scale dam construction in the U.S. took place in the first half of the 20th century with the largest and best known projects being the Hoover Dam, the Grand Coulee Dam, and the Tennessee Valley Authority projects. Many other water storage projects followed, some for flood control and others for irrigation, in addition to the need for electricity generation. All told, there are 80,000 dams in the U.S. Construction authority for these dams has traditionally been divided between the U.S. Army Corps of Engineers east of the Mississippi, and the Bureau of Reclamation of the Department of the Interior west of the Mississippi.

Of the 80,000 dams on national rivers and waterways, only about 2,500, or only about 3 percent of the total number of dams, generate electricity. The U.S. Department of Energy estimates that hydropower accounts for only 6 percent of total U.S. electricity but almost two-thirds of total renewable energy production.

Last year the Energy Department issued a report estimating that retrofitting existing flood control and irrigation dams with turbines could generate upwards of 12 gigawatts of electricity, increasing existing hydropower capacity by at least 15 percent.

Surprisingly, virtually all discussion regarding expansion of clean, renewable energy to meet expanding demand and to replace carbon fuels, has focused on wind and solar. This is the result of more successful education and advocacy by those two emerging industries, the failure of similar advocacy by the hydropower industry, the lack of knowledge about hydropower by both the public and political policy makers, and by a lingering desire by environmentalists to remove dams from rivers and waterways.

A recent *New York Times* editorial applauded the destruction of a dam on the Penobscot River in the State of Maine, allowing migration of salt water fish into upstream fresh-water channels. But the same newspaper, known for its advocacy of clean, renewable energy, failed to recognize the potential contribution of retrofitted dams for hydropower generation to achieve that objective. In short, large-scale removal of existing dams cannot take place if a substantial increase in hydropower to meet clean energy objectives is to take place.

IGNORANCE, RED TAPE AND UNEVEN SUBSIDIES

In addition to ignorance concerning clean hydropower, there are two other barriers: lengthy regulatory processes, and uneven subsidies. Building new hydro capacity or retrofitting existing dams in most cases requires federal government licensing approval, where interstate waterways are concerned, and approval by state licensing authorities as well. This is extraordinarily time-consuming. This regulatory licensing process requires serious streamlining. Additionally, U.S. taxpayers and private companies receive subsidies for local wind and solar projects, subsidies not available to hydropower projects. At the very least, hydropower should compete on an even plane with other renewables where licensing and subsidization are concerned.

Even without subsidies, professional estimates are that, compared with wind, solar, and even natural gas, the cost of hydropower per kilowatt/hour is the most economically competitive source. This, plus natural geography, has caused Brazil to generate 80 percent of its electricity from hydropower, Canada about half its electricity demand, and Norway up to a stunning 95 percent.

As *Oil* continues to document, we live in a global economy dominated by oil and gas and carbon-based energy supplies, and will continue to do so at least until the mid-21st century. But this world and its economy are in transition, and sophisticated readers of *Oil* know that energy demand is increasing even as supply comes from a smorgasbord of sources. That would be true even without climate concerns.

One major concern is about petroleum energy supplies, but the entire energy picture is worrisome. Whether producers or consumers, we all must consider the full range of energy supplies, especially those that are readily available with technological upgrading.

President Obama has set as a goal for the United States production of 80 percent of electricity from clean, renewable energy sources by the year 2035. This goal cannot be reached without a substantial increase in the contribution from hydropower. ■

Numbers

80,000

DAMS on rivers and waterways in the United States; only 2,500 are used to generate electricity.

6%

OF U.S. ELECTRICITY comes from hydropower, accounting for almost two-thirds of total renewable energy output in the country.

80%

OF ELECTRICITY must come from clean and renewable sources by 2035, according to the goal set by U.S. President Barack Obama.

95%

OF NORWEGIAN ELECTRICITY comes from hydropower. Canada generates about half of its electricity from hydropower, while Brazil is at 80 percent.

Gary Hart is a former United States Senator. He is currently Chairman of the American Security Project and a member of the U.S. Energy Security Council.

Fracking: the whole truth

by MICHAEL WEBBER

Hydraulic fracturing – or "fracking" as the *Wall Street Journal* calls it – is in the news for a whole variety of reasons. The increased production of liquids and gases from shale formations in the United States has shifted the international balance of trade, impacted the environment (both good and bad), and raised a debate about the future of this technique's suitability in other parts of the world. In many places the most controversial aspects of hydraulic fracturing are about its water impacts. Consequently, this piece will examine the relationship of water and fracking.

Concerns over the quantity and quality of water resources used in hydraulic fracturing are only partly justified. Furthermore, fracking has helped to cut CO_2 emissions to record lows in the United States

WATER FOR FUELS PRODUCTION

It is well known that the fuels sector—namely oil, gas, coal, uranium, and biofuels production—requires water. Water has been used for decades with techniques such as waterflooding to increase productivity in conventional oil and gas production. Biofuels also consume water during photosynthetic growth. And recently, water laced with additives such as sand and chemicals has been combined with horizontal drilling and hydraulic fracturing to unlock resources from shale formations. So far—for a variety of reasons, including the regulatory framework, private property rights, market structure, and multi-decade policies that supported hydraulic fracturing advances with R&D investments from the federal government – large-scale shale production has been a uniquely American phenomenon. That also means the fight over fracking is taking place mostly in the United States, while other countries wait to see what the outcome will be. For many stakeholders in this fight who are opposed to fracking, water is the tool that is used for protest.

So what is the truth about water and fracking?

Shale oil and gas production typically requires approximately 3 to 30 million liters of fluids per well. [Nicot and Scanlon, 2012] About 225 metric tons of sand and chemical additives are mixed in with the (typically) fresh water to make the frac fluids, and then they are injected into the well at a rate of thousands to tens of thousands of liters per minute. [DoE, 2009]

Those wells also return significant volumes of wastewater comprised of drilling muds, flowback water, and produced water. [Lutz, 2013] The wastewater often has very high TDS (total dissolved solids), which can be difficult to treat or dispose. Often the wastewater is stored on-site in ponds or pits, and sometimes it is trucked to specialized industrial treatment plants. Underground injection is considered an environmentally-friendly and long-lasting solution, as it sequesters the wastewater out of the surface ecosystem. While that technique is common in places like Texas, where there are tens of thousands of wastewater injection sites, in Pennsylvania (where the heart of the energy-rich Marcellus Shale is located), there are only a handful of injection sites. Consequently, wastewater management is a large ordeal in Pennsylvania and other locations where injection sites are scarce.

The water intensity of shale production is controversial for a few reasons.

First, the magnitude of water that is needed is surprising to many people.

Second, some of these shale plays are near urban areas, which means that oil and gas companies are in competition with other users for the water. Drilling pads are sometimes in backyards or church parking lots, which can make municipal water users fear the long-term availability of their water supply.

Third, because of the chemical composition of the frac fluids and the saltiness of the wastewater, many people worry about long-term degradation of local water quality.

Fourth, because of widespread drought and water scarcity, there is concern that water constraints will inhibit oil and gas production.

Despite all these concerns, the water used for fracking has been part of a good news story in that it enables greater energy production. And the subsequent abundance of natural gas has lowered prices, allowing natural gas to displace coal in the U.S. power sector. As a result, shale gas has helped reduce national emissions of CO_2 in the United States to the lowest level in nearly two decades. But, for water-scarce regions, it might also be bad news as the producers will require significant volumes of water while stoking fears among locals about water quality risks.

THE CONTEXT

But are the water needs of fracking really that high? The lifecycle water intensity shows that conventional fossil fuels and unconventional natural gas are relatively water-lean. In particular, biofuels are more water-intensive by about 2 orders of magnitude. That means biofuels are even more susceptible to restricted production because of drought than are oil and gas production.

It is important to note that despite the additional water used with hydraulic fracturing to produce natural gas from shale formations, natural gas use saves water over its entire lifecycle because natural gas combined cycle power plants have less than half the water intensity of coal plants. In other words, even though natural gas from shale for-

mations requires additional water for extraction, because of the water savings at the power plant (natural gas combined cycle power plants are much more efficient and cleaner than conventional coal plants, saving water), shale gas might be leaner from a water perspective than people might anticipate. That is not much comfort in some shale plays, as the localized water impacts from shale gas extraction can still be significant, and the water savings at the power plant might occur elsewhere.
Though shale gas for the power sector is relatively water lean over its entire lifecycle, it is still a major user at the point of extraction, which means water scarcity from drought can constrain shale gas production. For example, the current drought that began in 2011 has led some groundwater conservation districts in Texas "to consider enacting specific water use restrictions against" hydraulic fracturing. [Allen 2013] Furthermore, droughts sometimes position the agricultural sector against the energy sector in a competition for limited water supplies.
Another contextual issue relates to water quality. While some of the accusations by opponents of fracking are overblown, it is important for oil and gas producers to admit that there are real risks to water quality from oil and gas operations. However, those risks are not quite where people have claimed. In particular, the hydraulic fracturing itself does not appreciably alter the risks to water quality. Because the well completions in shale formations operate at higher pressures and with additional chemicals than for conventional wells, there is greater risk of failure from suboptimal cement work. But, the biggest risk is at the surface from two sources: 1) pits or ponds that temporarily store the wastewater might leak if they are unlined or badly lined, and 2) trucks carrying frac fluids or wastewater can get into accidents, causing spills that can contaminate surface water. These accidents have happened, so their likelihood needs to be taken seriously. It is also important to note that those risks are not specific to hydraulic fracturing; rather they are present wherever oil and gas operations are prevalent. So another way to think about it is that, any time there are increased oil and gas operations nearby, local stakeholders have a right to be concerned about their water.
Another item to keep in mind is that even though shale production poses risks to water quality, other conventional fuels also pose water-quality risks: surface mining for coal has many famous examples of impacts on surface water, and biofuels also can lead to nitrogen-laden runoff that gets into the waterways. [Twomey, 2010]

THE FUTURE

There are two key water-related trends to watch with fracking: the first is growing production. The number of wells is expected to increase globally. The second trend is that wells will decrease their water intensity with time. While it is good news that wells will require less fresh water for each completion, when accounting for the additional number of wells, it is possible (and likely) that overall water use for oil and gas production from shale formations will increase. Thus, we can expect additional pressure on producers to aggressively pursue strategies that minimize water requirements.
There are several approaches worth considering. One technique is to use more chemical additives: this approach has a tradeoff. While the additional chemicals can achieve higher performance and reduce the water requirements, the chemicals themselves are also controversial, and so it is possible that key environmental stakeholders will be unsure of the value of this tradeoff.
Other approaches include waterless fracking (for example by using nitrogen-based solutions, or propane gels), water reuse from well to well, and alternative supplies by use of degraded sources such as effluent from wastewater treatment plants, brackish groundwater, or seawater. One approach my research group at the University of Texas is exploring is the use of gases that normally would be flared for on-site thermal distillation of the produced water. That method would simultaneously solve two environmental issues by reducing flaring and the volume of produced water that requires disposal.
Because on-site treatment and reuse technologies are proliferating, because producers extract and handle far greater volumes of water than oil and gas, and because water is increasing in price globally, it is also possible that oil and gas companies will eventually become oil, gas and water companies. That day might arrive sooner than we think.

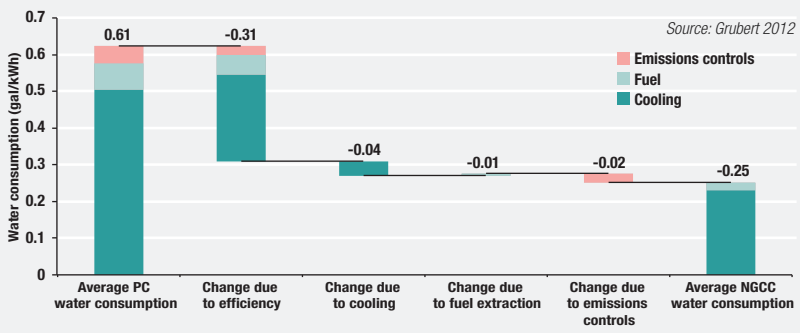
TECHNICAL AND POLICY SOLUTIONS

In light of these trends, it is worth contemplating some of the different technical and policy solutions that are available. A few of them are noted here:

- *Collect, maintain and make available accurate, updated and comprehensive water data*. There are many governmental agencies, trade associations, and companies that maintain extensive databases of accurate, up-to-date and comprehensive information on energy production, consumption, trade, and price with temporal and geographic resolution and standardized units. Unfortunately, there is no equivalent set of data for water. Consequently, industry, investors, analysts, policymakers and planners lack suitable data to make informed decisions.
- *Encourage water-switching to improve the energy sector's reliability.* Using reclaimed, brackish, grey, or sea water for hydraulic fracturing can overcome constraints induced by drought and can spare freshwater resources. There are, however, financing, regulatory and permitting hurdles in place that restrict this option.
- *Invest heavily in R&D*. R&D investments are an excellent policy option for governments as industry usually is not in a position to adequately invest in research barriers that are industry-wide. R&D for better treatment technologies, advanced techniques for hydraulic fracturing, and decision-support tools would all be valuable. At the same time, the amount of R&D in the water sector [Kirshenbaum, 2012] is much lower than for other sectors such as pharmaceuticals, technology, or energy, so water R&D overall should be increased.
- Set up functional water markets. In many places, oil and gas producers compete for water with agriculture and other users. The case with agriculture is particularly interesting: farmers usually have a lot of water, but need money; oil and gas producers usually have a lot of money, but need water. Normally, those conditions would be settled by a highly-functioning market. Unfortunately, highly functioning water markets are rare worldwide for a variety of policy, legacy, and philosophical reasons. Establishing efficient markets with clear rules and prices that accurately reflect the value of water would go a long way towards resolving inefficient allocation of water.

The vulnerability of the energy sector to droughts is important and not obvious. The concerns by stakeholders about the relationship of hydraulic fracturing with water quantity and quality are serious and are not likely to disappear anytime soon. Thus, it is in the best interest of producers, regulators, markets, and other stakeholders to pursue some of the options above. Doing so opens up the door for increased consumption and decreased environmental impacts, which is a win-win scenario for civilization.

FRACKING AND WATER, THE TEXAS "CASE"



Natural gas combined cycle plants use much less water than equivalent coal plants, even if the natural gas was produced by hydraulic fracturing.

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India/Half of water demand may go unmet by 2030

A threat to growth

Despite its abundant monsoons, India – which will become the world's third-largest economy within this century – suffers from perennial water shortages that also pose a major threat to relations with its close and powerful neighbor, China

by JAMES CRABTREE

In the midst of each year's monsoon, it seems difficult to imagine India as a nation is the grip of a water crisis. The rains dump roughly three-quarters of the country's annual rainfall in three torrid months. Slums in cities turn a sudden tinge of blue, as residents patch over makeshift roofs with azure tarpaulin sheets. In the countryside, once-parched hills turn deep green instead, while farmers and government officials wait nervously to see if the deluge reaches normal levels. If not, next year's crops will suffer, as will the whole country's growth rate. Few could doubt the force these arrivals bring this year at least, as the world's television's cameras panned in to the northern mountain state of Uttarakhand. Dubbed the "Himalayan tsunami," the rains saw flash floods crash through villages and valleys cut off with mud-slides. More than five thousand died, among them numerous devout Hindu pilgrims.

Put bluntly, at monsoon time there is water everywhere, while this year the rains have been generous as well, calming worried economists and agrarians alike. And yet, in an irony that escapes few who examine the topic, such temporary abundance disguises a more lasting shortfall. In India, around 100 million people have no access to clean water at all. The average Indian woman must walk many kilometers each day to find a reliable source. There isn't a town or city in the entire country that can offer round-the-clock supplies. Worse, without prompt and decisive action, this situation is set to deteriorate rapidly.

GROWING DEMAND FOR WATER

Demand for water is going up worldwide, rising by more than 50 per cent to 6,900 billion meters cubed a year by 2030, according to the consultancy McKinsey – a level one-third above today's supplies. But in India the outlook is much worse. The United Nations already labels Asia's third largest economy as "water stressed," the worst status the body offers. But the same McKinsey data suggest demand here is set roughly to double over the same period, after which time half of all demand will be unmet. The result will be the most pronounced water crisis of any major global economy, and one that could undermine India's precarious rise as a great world power.

The nation's government is not blind to the task. Montek Singh Ahluwalia, a senior technocrat and a close advisor to Prime Minister Manmohan Singh, describes water as one of the country's three gravest long-term challenges. "We are now near balance, although over the next ten or twenty years, on a business-as-usual basis, the demand for water will hugely outstrip supply," Mr Ahluwalia said at a conference I attended last year. "Some increase in supply is possible, but a lot of this is going to have to come from more efficiency." Even today, India is dotted with simmering water disputes between states and within cities, as competition intensifies for resources provided by the Ganges, the Brahmaputra and other great river systems. Water disputes also complicate relations with neighbors, notably Pakistan and China. But with demand rising across the continent, such water tensions could soon escalate dramatically, with some experts warning of the risks of "water wars" between the countries.

Arunabha Ghosh, the chief executive of Council on Energy, Environment and Water, a think tank in New Delhi, puts the challenge in different, but equally stark, terms. "Most major economies go through a cycle in which they move from agriculture to industry to services, and this sequence makes demands on the country's resources in turn," he says. "But the real challenge for India is that really unlike any other large country, its development path is such that all three of these major parts of its economy are going to be growing simultaneously over the next few decades, and therefore the demand for water and the pressure for water resources is going to be unlike anything any other major country has ever faced before."

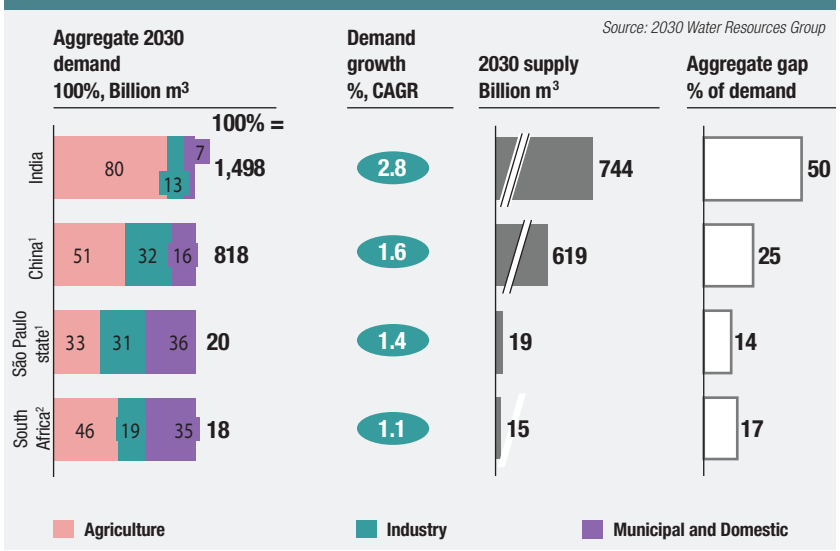
MUCH REMAINS TO BE DONE

India's water resources are unevenly distributed. Much of the country's annual rainfall comes in the mountainous north and west, leaving more pronounced supply problems in drier states, like Gujarat and Rajasthan in the west. One weak monsoon is enough to tip even more water-rich areas into trouble, however, as happened earlier this year to 20 million people living in drought-affected regions of the western state of Maharashtra. Agriculture in such water-scarce regions faces particular difficulties, not least because, while India has plenty of programs to start building canals to irrigate farmland, it is much less good at completing them, or indeed keeping them maintained and functioning – leading to unreliable supplies.

The country's sprawling cities face different challenges. One study suggested that the creaking water system in Mumbai, the nation's financial capital and home to an estimated 25 million people, wasted a staggering 650 million liters of water every day, a result of dreadful governance as much as leaky pipes. In a perverse twist, this also means the country's very poorest often have to pay far more than its wealthier residents per liter, with those in slums often reliant on supplies driven in by tankers, whose offerings are usually expensive and often unclean. And all of this comes without factoring in the forces driving future increases in demand. India's economy is likely to become the world's third-largest by mid-century, while the country is also set to witness one of the largest migrations in human history, as hundreds of millions move into these urban areas. It will industrialize further too, creating new water demands from factories and power stations.

THE GAP BETWEEN WATER SUPPLY AND DEMAND

Source: 2030 Water Resources Group



India, China, São Paulo state and South Africa, in 2030, will account for 30 percent of world GDP and 42 percent of projected global water demand. Indian demand will grow to almost 1.5 trillion m³. Against this demand, India's current water supply is approximately 740 billion m³.

1 Gap greater than demand-supply difference due to mismatch between supply and demand at basin level.
2 South Africa agricultural demand includes a 3% contribution from afforestation.

THE "BATTLE" WITH CHINA

It is pressure from factors like these that lead some analysts to predict trouble ahead. Prime among them is Brahma Chellaney, a security analyst at the Centre for Policy Research in New Delhi, whose book *Water: Asia's New Battleground* paints a dispiriting picture. Mr. Chellaney notes that much of India's water stems from the Tibetan plateau, an elevated area that houses the source of many of the large rivers that flow down into South and East Asia. Competition →

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for their resources is already fierce, but he points a finger at China in particular, accusing the world's largest developing economy of excessively aggressive water policies. "Given pressures of development, population growth and increasing water stress in both South Asia and northern China, these stresses are only likely to get worse," Mr Chellaney says. "These are the realities which will drive water competition, and that will solidify the linkage between water and conflicts between nations in this region."

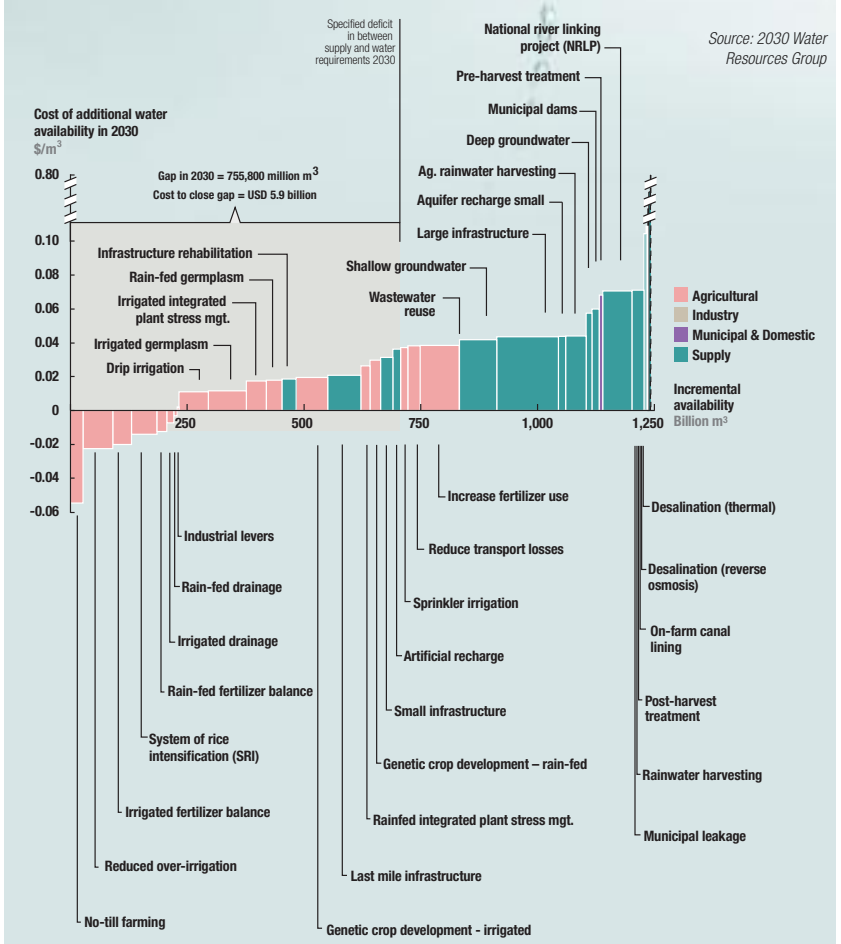
The prospect of actual armed conflict is slim, but India's largest neighbor presents intriguing contrasts in other ways. Both nations face deep water shortages, but they are likely to be driven by different factors: China's demand surge comes largely from its industrial base, while India's will be overwhelmingly agricultural. The two countries have followed different water strategies to too. China has attempted giant projects to increase and redirect water supplies, not least the Three Gorges Dam, which cost around Rmb250 billion ($41 billion) upon completion in 2006. India has analogous schemes, on paper at least, including improbable plans to connect parts of some of the country's more than one dozen major water basins. Yet for all this it has built virtually no large Chinese-style dams in recent years. Equally, many experts believe such epic plans are at best only one element of the solution to India's pending water troubles – and could even be counterproductive. "We are trying to shift from an approach which is largely supply-driven to one that is more about efficiency and productivity, to manage demand," says CEEW's Mr. Ghosh. "Supply is part of the answer, but there are far more cost-effective ways to deal with the water problem, without resorting to more dams and mega projects that try to move water thousands of miles around the countryside."

COMBATING WATER SHORTAGES

In the absence of such measures, meeting the country's water demand requires a focus on at least three other areas. The first is agriculture, the sector that will drive roughly 80 per cent of the demand jump by 2030. "India's water problem is fundamentally an agricultural efficiency problem, although it also requires steps to ensure industries do not damage water supplies, and households obtain access," says Rajat Gupta, a Mumbai-based partner at McKinsey who has studied water issues.

Higher productivity levels requires changes in farming practices, in particular a movement away from water-intensive crops, such as cotton and sugar. This is no easy solution, especially when many powerful Indian politicians have vested interests in the production of these same crops. New farming techniques are crucial too, such as "drip" irrigation, in which sprinklers or other water sources replace the practice of simply flooding fields. "In the past we have relied on physical large scale investment projects because they are often easier to think about doing," Mr Gupta says.

The water availability cost curve for India



The total cost of the measures needed to increase water availability in India is about $6 billion a year, or slightly more than 0.1 percent of the estimated GDP for 2030. The gap between the country's water demand and supply would be reduced by 80 percent with a series of measures to implement agricultural techniques.

"In fact, retraining and helping a million farmers to do something different with the way they do agriculture, this is extraordinarily difficult to do, but that is the sort of thing that now needs to happen."

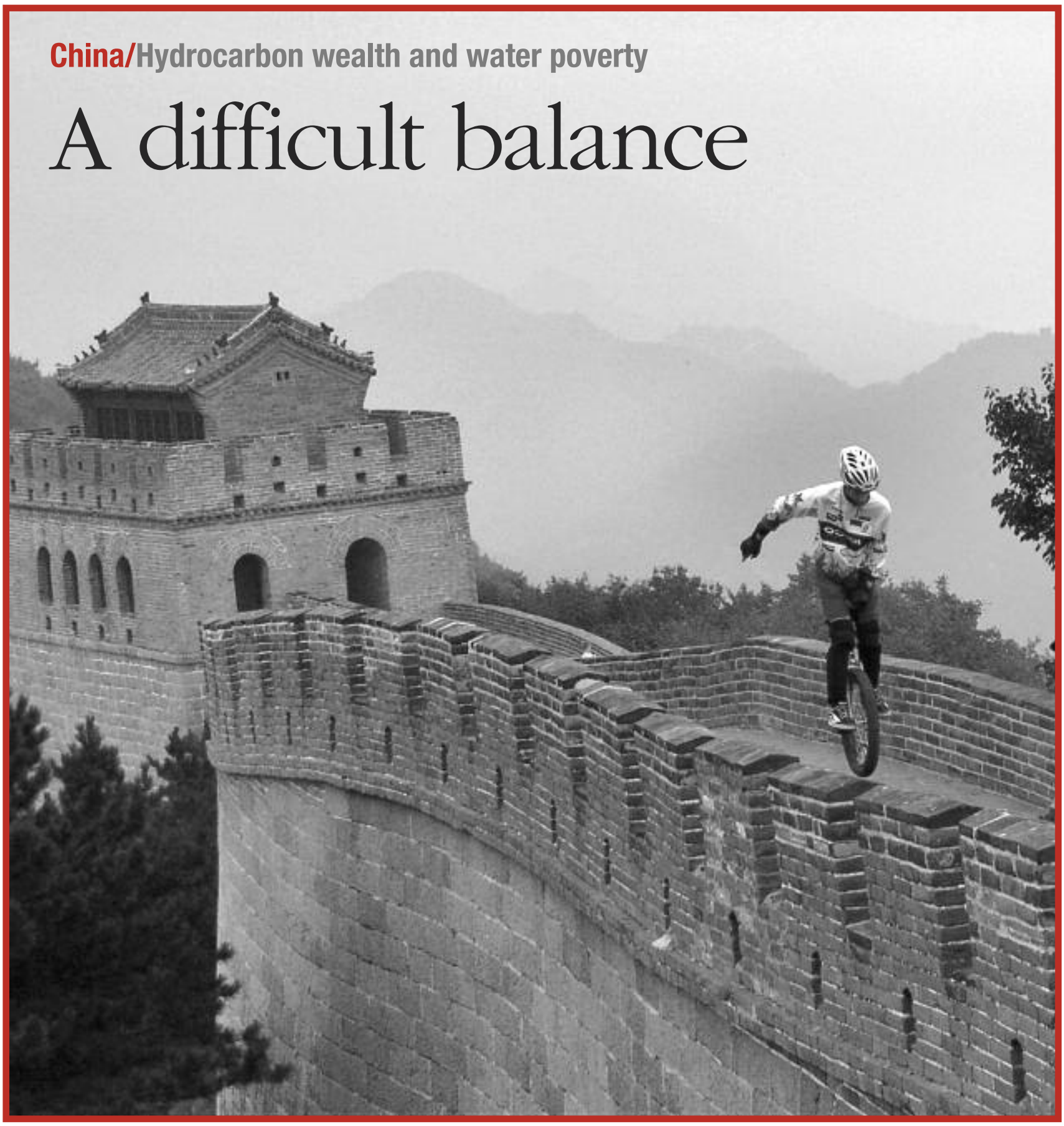
Comparable measures are needed in the industrial sector too, in particular to nudge larger companies to conserve water, and to avoid polluting public supplies as well. The private sector must also be harnessed to develop new water-saving technologies and products. But it is in a third area, the country's seething cities, that presents perhaps the greatest challenge. Here water conservation efforts are already beset by fractured supplies, negligible data and weak regulation. "If you look at the urban sector, it is a problem of overlapping government responsibility. The same agency tends to be the designer, the implementer, the funder, and the regulator," says Smita Misra, an economist at the World Bank. "There are huge benefits from creating new service providers who are accountable to the consumers," she says, pointing to the need for the creation of local water utilities, as well as clear property rights over water resources, as a first step.

A LITERARY PARALLEL

Take this together, and it is perhaps no accident that the central character in novelist Mohsin Hamid's new book *How to Get Filthy Rich in Rising Asia* ends up making his fortune as a corrupt water tycoon. "Your city's neglected pipes are cracking, the contents of underground water mains and sewers mingling," the author writes, as he describes a young man who moves from the countryside to begin an often-violent career as a bottled water entrepreneur in a nameless South Asian megacity. "Taps in locales rich and poor alike disgorge liquids that, while for the most part clear and often odorless, reliably contain trace levels of feces and microorganisms capable of causing diarrhea, hepatitis, dysentery and typhoid," he writes. India's ultimate water challenge must be to ensure that, over the next two decades, such descriptions are restricted to the realm of fiction once again.

China/Hydrocarbon wealth and water poverty

A difficult balance

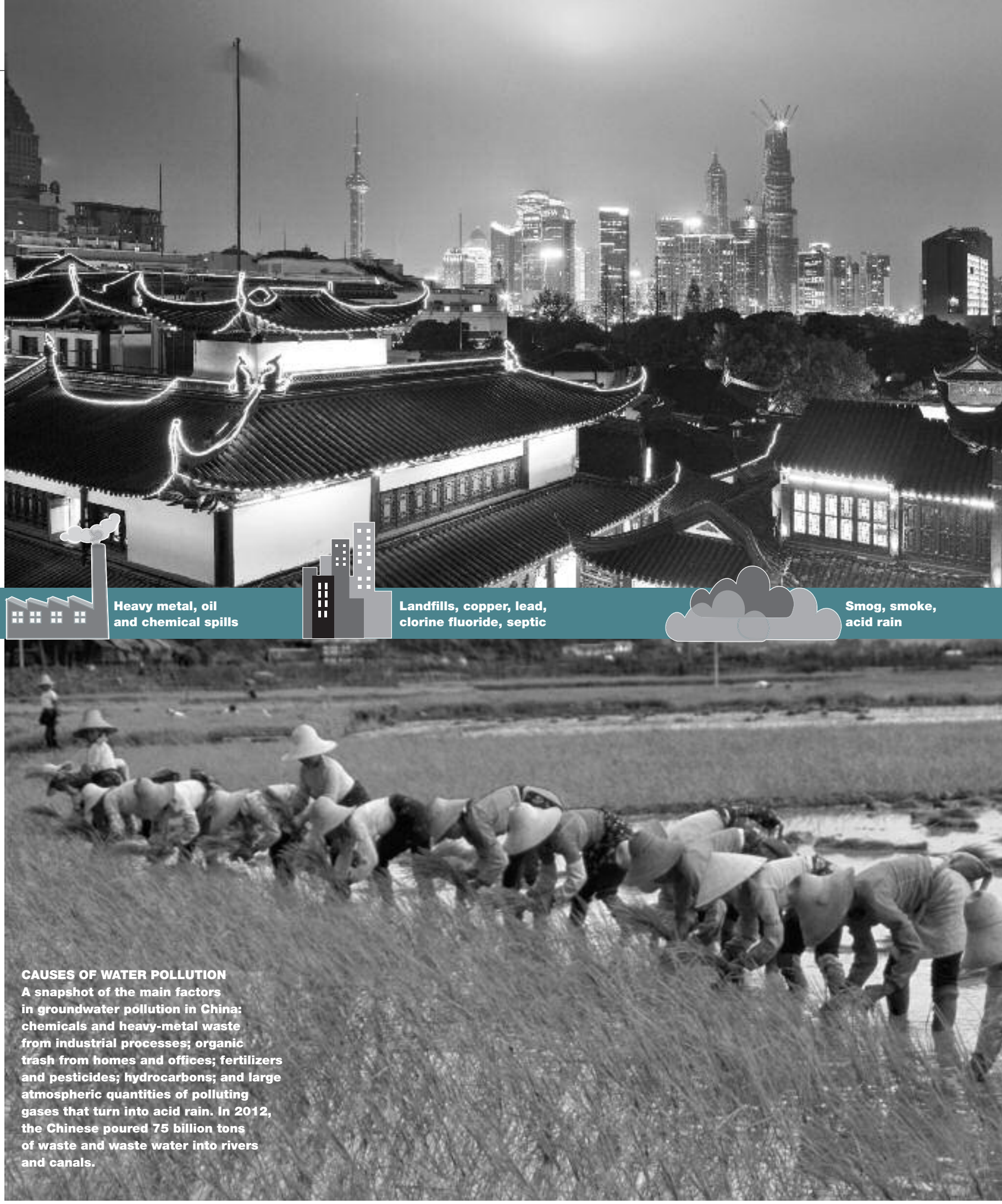


Approximately 300 million rural people and two thirds of city-dwellers do not have enough water. Forty percent of the country's rivers are seriously polluted. Government control is scanty and careless

by YAO JIN

Energy and water are two words that do not go together in China. As production of the former increases, resources of the latter are continuously diminished. The pattern occurs frequently, albeit in some areas more than others, and is caused by particular industries. Despite the government's efforts to reduce resource usage in the name of a habitable environment and social stability, the figures are troubling.

There are 10,000 petrochemical plants along the Yangtze and a further 4,000 along the banks of the Yellow River. According to a study conducted last year, around 40 percent of Chinese watercourses are seriously polluted, while 20 percent of these are thought to be so polluted that an organism can be damaged simply by coming into →



CAUSES OF WATER POLLUTION
A snapshot of the main factors in groundwater pollution in China: chemicals and heavy-metal waste from industrial processes; organic trash from homes and offices; fertilizers and pesticides; hydrocarbons; and large atmospheric quantities of polluting gases that turn into acid rain. In 2012, the Chinese poured 75 billion tons of waste and waste water into rivers and canals.

contact with the water. Official figures say that about 1,700 negative incident are caused every year by the pollution of the water table. Moreover, the health costs are extraordinarily high, with roughly 60,000 premature deaths each year. This trend has been running for years now and is a matter of some concern among the highest political levels of China. Each year politicians must face about 180,000 protests, many of which relate to environmental issues. In 2007, a report by the World Bank revealed that about 750,000 Chinese people die prematurely every year because of pollution (although the main cause in this case was air pollution). When this was discovered, the Environmental Protection Agency and the Ministry of Health asked the World Bank not to disclose the premature deaths statistic, precisely to avoid a popular outcry.

A recent incident illustrates the scale of water table pollution: only a few months ago, a businessman in Zhejiang, on the Chinese coast, offered a local official the equivalent of $30,000 to swim for just 20 minutes in a nearby river. The official did not take up the challenge, because of the high concentration of toxic substances in the water. Indeed, during 2012, some 75 billion tons of sewage and waste water were dumped into China's rivers and canals. This figure points to a genuine emergency, if we consider that the people of China

Pesticides, nitrates, fertilizers

consume 600 billion cubic meters of fresh water each year. About 300 million people in the countryside are short of water and two thirds of city-dwellers have a serious lack of drinking water. Politics is part of the problem. Pollution of water resources is exacerbated by the lack of accurate controls and the shortage of independent organizations to carry them out. Local administrations also have a tendency to hide the real statistics on pollution.

INNER MONGOLIAN COAL

The coal industry is among the greatest contributors to the pollution of the water table. The latest report on the pollution of China's waterways was produced by the East Asia section of Greenpeace, which in July published "Thirsty Coal 2" on the effect of the coal processing industry on the waterways in Chinese Inner Mongolia. The outcome was labeled "alarming" by the environmentalist organization in a note accompanying the study, which was conducted on site during the four months prior to publication.

The blame has been laid at the door of Shenhua, China's largest coal group, which in 2006 promised to eliminate dumping and to use a minimal amount of water for extraction work. Seven years on, Greenpeace has discovered that these promises have not been kept: in Ordos alone, 50 million tons of water have been used, lowering the water table by 100 meters and therefore causing serious damage to agriculture. Local farmers have been forced to leave their land and move elsewhere. According to Greenpeace's calculations, one of the lakes in the area, the Subeinaoer, has shrunk to a third of its previous size. Greenpeace also made a brave and unprecedented decision in the report: for the first time ever, it mentioned the name of a company (moreover, one that is partly state-owned) that is responsible for the pollution – Shenhua. Inner Mongolia is strategically important for the coal industry. The autonomous Chinese region holds 26 percent of national reserves, but only has 1.6 percent of its water. The risk of desertification is higher there than elsewhere, and 73.5 percent of the area's plains are now in a state of environmental degradation. Inner Mongolia is not the only place where water is consumed for the coal industry. The same also happens in the coal-rich autonomous region of Ningxia Hui. Between 2001 and 2005, the coal industry there consumed at least 800 million m^3 of water from the Yellow River each year – more than 25 percent above the legally allowed amount. Between 2003 and 2006, there were repeated warnings that the river might dry up if the rate of water consumption stayed the same. Moreover, these figures relate only to water usage, not pollution. The inhabitants of Ningxia Hui and Inner Mongolia even risk losing their drinking water because China's five largest coal companies flush their industrial waste from sites along the upper and middle parts of the Yellow River. Each year, the coal companies spew more than 80 million tons of waste water into the river, costing 11.5-15.6 billion yuan each year (1.4-1.9 billion euros at current exchange rates).

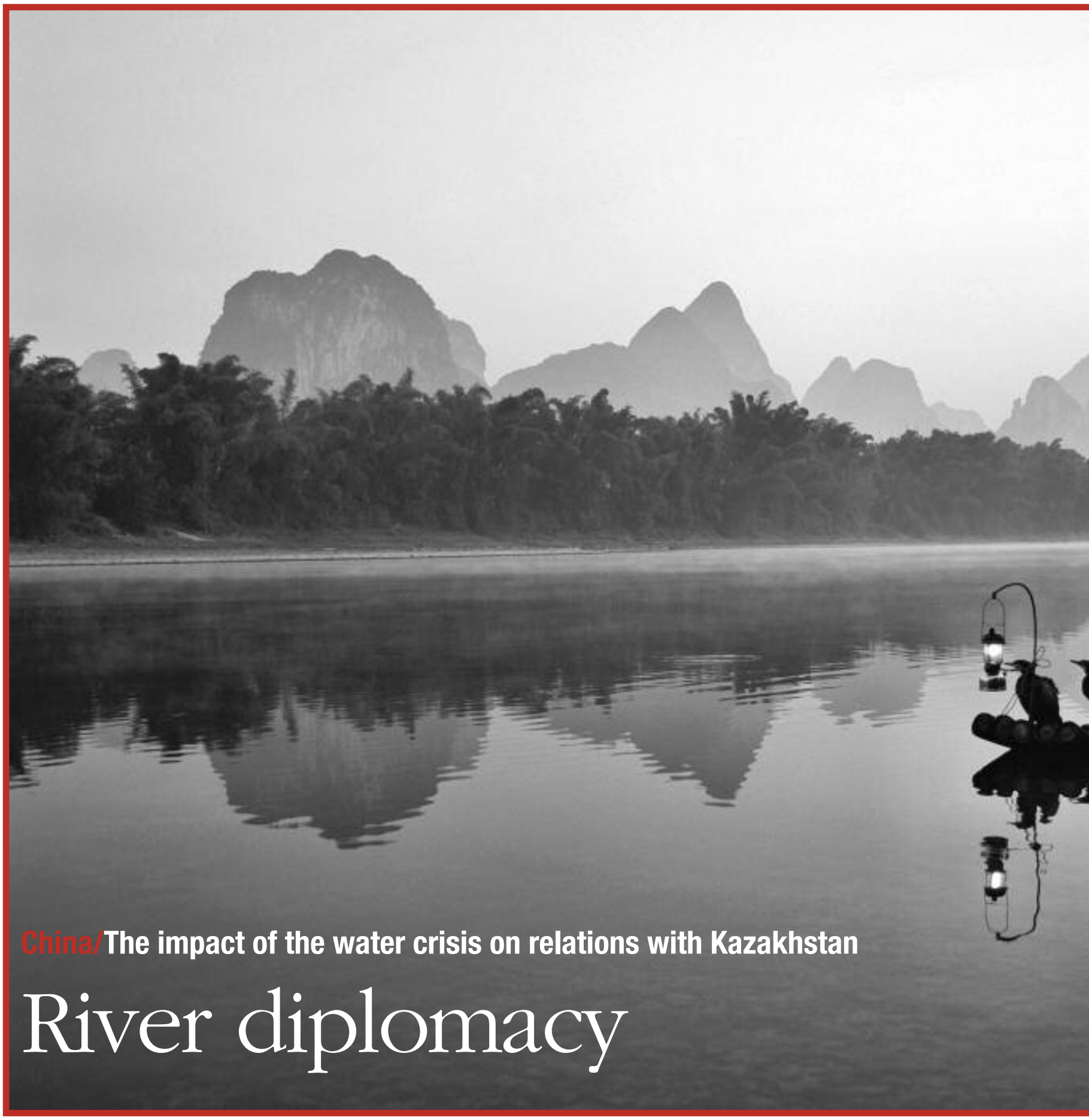
> About 1,700 negative incidents are caused annually by water-table pollution, and the health costs are extraordinarily high: 60,000 people die prematurely each year

SHALE OIL AND GAS

Coal is not the only factor in the worsening state of China's water. According to a UNESCO study, unconventional sources like shale oil and gas consume huge amounts of water: for every ton of shale oil produced, China uses an average of nine tons of water. This, in turn, produces five tons of waste products.

Crude extraction, on the other hand, mainly threatens China's seas. A report from last year by the State Oceanic Administration uncovered some striking statistics. More than 17 million metric tons of pollutants have flowed into China's seas from 72 rivers monitored by the agency. Out of this enormous quantity of industrial waste, 46,000 tons are from mineral processing and 93,000 from crude oil processing. This does not even take account of accidents on open-sea oil rigs. In 2011, for example, a leak spilled more than 3,300 barrels of crude oil into the Bay of Bohai, covering 6,200 square kilometers of sea in an oily blanket. In the period between 2006 and 2010 alone, the Ministry of Land and Resources recorded 41 such incidents. In just the last year, the area of coastal waters classed as severely polluted has increased from 44,000 to 68,000 km2, according to late-2012 figures.

Shocking statistics aside, the pollution of the water table is a fixture on the public agenda in China. On August 6, seven people were arrested in the autonomous region of Guangxi, southern China, for dumping mineral processing waste containing toxic elements such as cadmium and thallium into the Hanjiang River, without complying with legal waste-disposal requirements. Alongside the pollution caused by major corporations, small refineries and local metal and rare mineral processing businesses also play a role. This often occurs with the consent of complacent authorities that are paid to turn a blind eye to the flagrant disregard of environmental protection regulations.



China/The impact of the water crisis on relations with Kazakhstan

River diplomacy

The oil trade has become the cornerstone of economic exchange between China and Kazakhstan, but there is still a certain lack of trust over the management and sharing of cross-border rivers. Sincere cooperation is important

by LIFAN LI

Oil and water are essential sources for human beings. Generally, in the main countries on Euro-Asia, where there is oil, there is a water shortage. Kazakhstan, which has a border 1783 kilometers long (567 is that is a water border) with China, is a typical example. China and Kazakhstan have established a comprehensive cooperative partnership and achieved a success in resource and trade cooperation. In the first half of 2013, bilateral trade volume between the two countries reached $13.57 billion, increasing 23.1 percent compared with the same period the previous year. The export volume from China to Kazakhstan reached

$5.66 billion, an increase of 30.5 percent. The import volume from Kazakhstan by China increased 18.2 percent, reaching $7.92 billion. In the area of energy, the second phase of the China-Kazakhstan natural gas pipeline, the second phase of China-Kazakhstan oil, and the Kazakhstan section of the third China-Central Asia natural gas pipeline are under construction. In the water sector, however, cooperation did not move as smoothly as in energy; this might become the weak spot in the trust between the two countries.

Currently the population of the world is well above 7 billion and it will increase a further 2 billion by 2050, causing a more serious shortage of water. In December 2012, the president of Kazakhstan, Nursultan Nazarbayev, illustrated in his State of the Union address that the global demand for drinking water in the last 60 years has increased eight-fold. From the middle of this century, many countries will be forced to import drinking water to satisfy internal demand, and the struggle for water will become an important factor in geographic politics. The special location and temperature highlights the significance of water usage. Upstream and downstream countries strive for water and remonstrate with each other. Many countries have protested the building of dams, and some even expected that the issue of water be addressed by the Shanghai Cooperation Organization.

FRAUGHT DIPLOMATIC RELATIONS

Many rivers cross borders in Middle Asia, where countries solve the shortage of water through bilateral or multilateral cooperation. There are five factors that may cause or influence conflicts related to water. The first is the relation between countries. Friendly countries do not have serious struggles about water. The second is economic. Countries with backward economies may depend heavily on natural resources. The third is the lack of a culture based on common interests and the protection of the environment. The fourth is an incapacity to use and protect water resources. The fifth is mistaken government measures and development strategies.

The misunderstandings and conflicts over water resources between China and Kazakhstan have been obscured by the rapid development of the two countries. After the President of Kazakhstan's February 2011 visit to China, much of the Kazakh media criticized him for not protecting the cross-border rivers between the countries and for letting China, upstream, determine the negotiations.

KAZAKHSTAN'S DISTRUST

Kazakhstan, which possesses a number of rivers and lakes, enjoys an abundance of water compared with many other countries in Central Asia. The volume of its fresh-water reservoir is about 90 square kilometers, the net flow is about 101 km^2, the underground water is 95 km^2, and ice reserves are 58 km^2; it thus holds 2.6 percent of the water resources of Central Asia. Due to uneven distribution and the rapid increase of demand, the shortage of water is becoming more and more serious, and many districts claim that they lack water. Within the country, there are 85,000 rivers, six of which are over 1000 km long. The longest river in Kazakhstan is the Eerqisi River, which is 1,700 km long. Forty percent of the surface water comes from cross-border rivers and only 56.3 of the 101.2 km^2 is totally within the country. The other 44.9 km^2 stems from cross-border water running across Kazakhstan and China, Russia, Kyrgyzstan and Ukraine. A volume of 23.6 km^2 of water comes from China. Thirty-three percent of the surface water in Kazakhstan flows to other countries.

There are 23 rivers crossing the border of China and Kazakhstan, among which the longest are the Eerqisi River and the Ili River. Kazakhstan, which lies downstream, focuses on the usage of the two rivers by upstream China and feels anxious that the building of dams and reservoirs may endanger its water supply. Where the Eerqisi River runs through Kazakhstan, it covers an area with a population of 2.5 million. Therefore, the sustainable development of energy, industry and agriculture is closely connected with the security of the river. Kazakhstan expects urgently to deal with the water resource together with China.

Kazakhstan pays great attention to water resources and formulates the relative protection and development strategy, and follows closely the utilization and protection of the cross-border rivers by the other countries. The 2003-2015 National Industry Innovation Development Strategy listed the improvement of water source usage as an important national policy. The status of and demand on water resources in Kazakhstan makes water an important strategic resource and attracts national attention.

"THE CHINESE WATER THREAT"

China's Xinjiang Province, next to Kazakhstan, is very short of water. As the two longest rivers in Xinjiang, Ili and Eerqisi provide the basic resources and become hubs in local economic life. The flow of the two rivers accounts for one third of local total flow. The runoff volume of the two rivers comprises 91.3 percent and 27.2 percent of the total in Xinjiang respectively. The cross-border rivers in western and northern China are far from development. The usage ratio of the cross-border rivers in Xinjiang is less than one fourth of the total, far lower than for the internal rivers. In order to push the economic development of Xinjiang's industry and agriculture, it will be urgent for the rivers to be massively exploited.

From the 1990s, in order to improve the economy in Xinjiang and satisfy water demand, the Project 635 water →

ENERGY RESOURCES IN CHINA
The map shows fields, pipelines, refineries and terminals located throughout the country, as well as the routes of pipelines for gas and for crude oil, including pipelines that are still in the design phase, heading toward Kazakhstan and other neighboring countries.

Source: Eni

transfer canal was launched in the north to develop the usage of the Ili and Eerquisi Rivers. The project to transfer the water of the Eerquis River to Karamay has solved the shortage of water in the city. During recent years, irrigation investment and construction has risen greatly and the watering of farmland has increased every year. Up through 2007, 492 reservoirs of different sizes were built, 20 of them large; the total capacity is 860.013 million m^2.

The Eerqisi River is the lifeline for the economic development of Xinjiang, providing water for the city and for part of the cotton land irrigation for Urumqi through a 300-kilometer canal. After entering Kazakhstan, the river is an important source for eastern industry and agriculture, and it provides necessary water for Alma-Ata. Kazakhstan constructed an Eerqisi-Karaganda canal to transfer the water to its new capital, Astana. After the transfer project built upstream on the Eerqisi by China, Kazakhstan frequently showed its dissatisfaction over the decline of the water level.

Facing the reality of the shortage of water resources and the increasing demand for water, the large-scale utilization of Eerqisi and Ili has aroused much concern and reproaches from Kazakhstan. The idea of a "China water threat" has provided good support for the idea of a "China threat" in the media from many countries. For example, Russia's independent newspaper pointed out that up to 2015, the demand for water in China and in countries from South Asia and Southeast Asia will increase rapidly. China, as the water source in this area, can use the exploitation of cross-border rivers as an effective means to restrain the other countries.

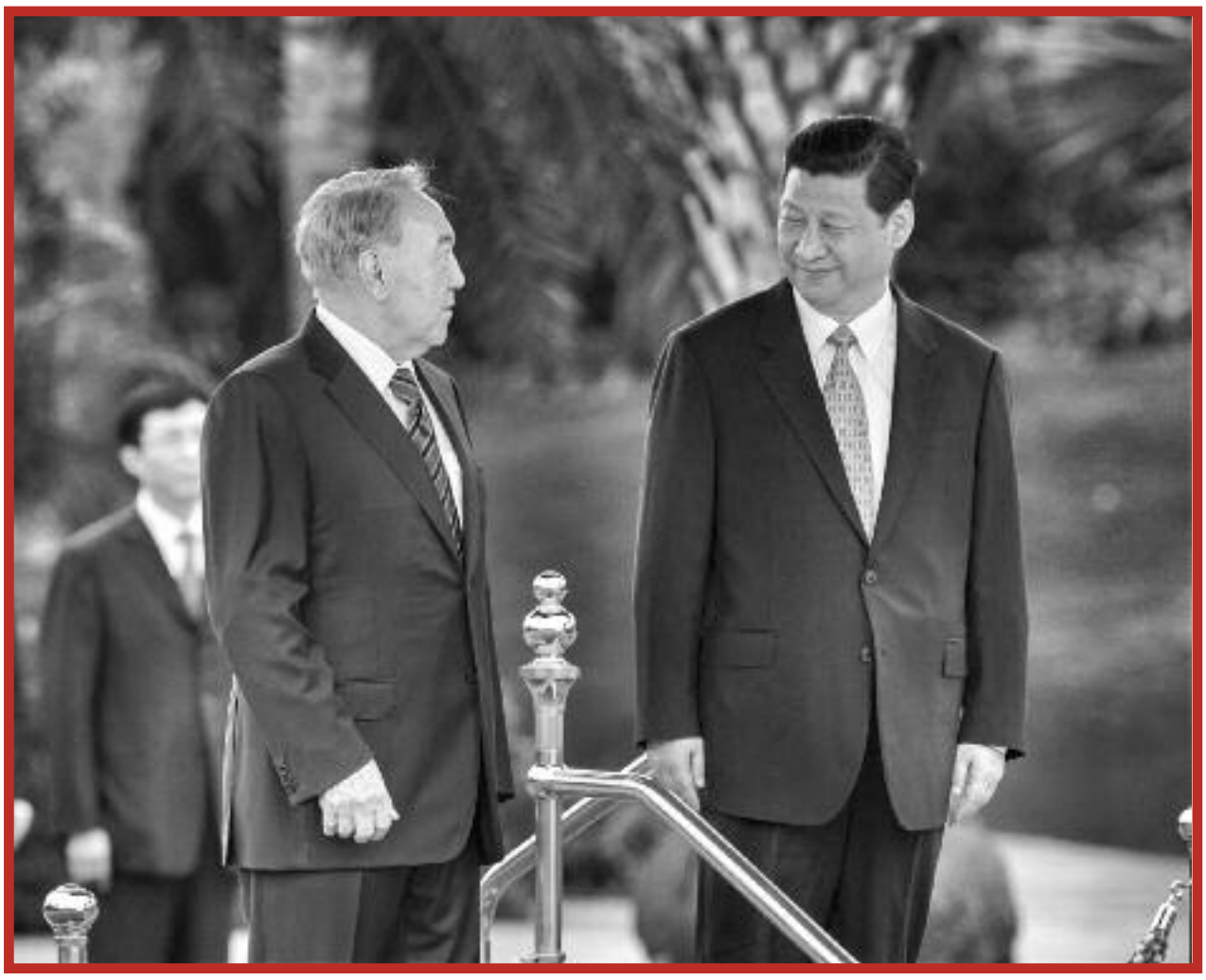
BILATERAL NEGOTIATIONS

The conflicts related to China-Kazakhstan water resources fall into a pattern of "Kazakhstan proposal and China response." The two countries established diplomatic relations in January 1992, based on an agreement over five principles for peaceful coexistence to develop a good relationship. During this period, China began its utilization of Ili and Eerqisi; later, Kazakhstan proposed the issue of the cross-border rivers. In 1992, Kazakhstan communicated to China the suggestion of using the cross-border water resource cooperatively and appropriately. In 1994, a draft agreement related to the issue, proposed by Kazakhstan, was sent to China. Concerned that the building of a canal to transfer water to Karamay might destroy the current balance, Kazakhstan persisted in setting up negotiations about the issue. In March 1999, President Nazarbayev sent a personal letter to then Chairman Jiang Zemin, stressing that the ecological issue between the two countries should be attended to. He proposed that China should solve the problems related to cross-border water resources and the two countries should launch the negotiation immediately.

> The border between China and Kazakhstan is crossed by 23 rivers. Kazakhstan is concerned that the construction of water reservoirs could endanger its water supply

China responded quickly and invited an expert group from Kazakhstan to visit China, to begin the first round of negotiation. In May 1999, the discussion by experts from the two countries was held in Beijing, and China promised to consider the interests of Kazakhstan in building the canal in Xinjiang. In October of the same year, the second round of negotiations was held in Alma-Ata. China affirmed that it was willing to sign an agreement on cooperative use and protect of the cross-border rivers. Both sides agreed to exchange information regularly on the construction of infrastructures on the Ili and Eerqisi Rivers. The next May, the third round of negotiations was held, again in Beijing. China stressed that it would consider the interests of Kazakhstan to the largest extent. The two countries passed the regulations of cooperative group of experts, stating that the proper utilization and protection of water resources should depend on research and co-appraisals. From then on, every year the experts from the two countries held a conference to solve any issues that emerged.

The good political relations between China and Kazakhstan created a friendly environment for the two countries and pushed the speed and effects of the negotiation. In 2002, the Treaty of Good-Neighborliness and Friendly Cooperation between China and Kazakhstan was signed. In 2003–2008 the Cooperation Guideline and Economic Development Perception was also signed, proposing to strengthen cooperation on the proper utilization and protection of cross-border rivers based on the Agreement on the Utilization and Protection of Cross-border Rivers by China and Kazakhstan. On October 27–31, the joint com-



A POLITICAL ISSUE
Conflicts linked to the river border between China and Kazakhstan are a political as well as an economic issue. In the photo, Chinese president Xi Jinping welcomes Kazakh president Nursultan Nazarbayev on a visit to Sanya, in southern China.

mittee on utilization and protection of cross-border rivers held its first meeting in Beijing. Friendly negotiation was launched and working principles were declared. In 2006, the two countries signed the Agreement on Research Cooperation on Cross-border Water Resources, Agreement on Exchanging Data about Hydrological Conditions on Cross-border Water Resources, and Agreement on the Principles Related to Boundary Management. On April 15, 2011, China and Kazakhstan began the construction of the Khorgos transfer project with an investment of $9.56 million. This was a concrete achievement after the signing of the Agreement on Co-Building the Khorgos Transfer Project, which was strategically important for the relations between the two countries. On July 5, the project, which transfers a runoff volume of 50 m2 of water every second (25 to each country), came into service. Nazarbayev, the deputy minister of the Environment of Kazakhstan who participated the project's completion ceremony, declared that the project ensured the fair utilization of the river and represented the mutual trust and sincere cooperation between the two countries.

The shortage of water resources is not an isolated problem, and it is closely connected with national politics and diplomacy. The main problem faced by the two countries for the next ten years will be how to avoid water risks between the two countries and dissolve the distrust between the downstream country and the upstream country. It is not the "price factor in the oil trade," but rather a problem of living essence.

THE SOLUTIONS

Kazakhstan has proposed measures to improve the sustainable utilization of water resources:

1. Centralize the water supply and enlarge the supply coverage: in 2001, following the guidance of President Nazarbayev, the government of Kazakhstan approved the 2001–2030 Drinking Water National Planning. Since then, 350 water supply spots were built. In 2012, water coverage reached 87 percent in cities and 43 percent in villages. Among the current 6,943 communities in villages, 2,999 have achieved central water supply. The percentage of the population that enjoys quality drinking water has risen from 75 percent to 87 percent.

2. Improve water quality and strengthen the construction of the pipeline network. Akhmetov, the Prime Minister of Kazakhstan, pointed out that in order to increase the coverage of quality water, the relative infrastructure should be modernized in every aspect. Currently, the water pipeline network of the country has reached 53,000 kilometers, of which 29,900 is in the cities and the other 23,100 is in the villages. Considering the aging of the pipelines, 31,800 km of them should be maintained. At the end of 2012, in order to modernize the water system, reorganize capital and economize on water resources, a new charging system should be set up and the price of water should be upgraded. Based on the Kazakhstan New Charging System Comprehensive Planning from 2013–2015, long-term planning was made, considering national support, investment attraction and an effective charging system.

> The puzzle is solving the water deficit that by 2030 could reach 14 billion m² in Kazakhstan and 40 billion in China, shifting the value of gross output by more than RMB 200 billion

3. Improve the intensity and efficiency of water utilization in the transfer to green economy. In 2017, Kazakhstan will host the World Expo, with the theme of future green energy. Therefore, there is an urgency to change the traditional economic mode, reduce dependency on non-recyclable resources, and lower the necessity of water usage in industry. Kazakhstan depends greatly on the rivers that cross the borders with China, Russia, Uzbekistan and Kyrgyzstan. With the rapid economic and social development of the surrounding countries, the flow of the cross-border rivers is reducing quickly. It is estimated that the flow may lessen by 40 percent by 2030.

4. Strengthen international cooperation through the U.N. Convention. According to the U.N. Convention passed in 1997, water resources should be shared. Kazakhstan takes advantage of good-neighborly and friendly relations with China to push the negotiation and assessment of the Joint Committee on Utilization and Protection of Cross-Border Rivers. It is expected that the two countries will reach an agreement on water resource assessment in 2014, which will be based on the water resource sharing agreement scheduled in 2015. The committee also decided to build small-sized irrigation facilities on cross-border rivers, and experts exchanged their suggestions on the dangers faced by the Khorgos River.

WATER WEALTH. Kazakhstan has abundant water resources and has proposed using national funds to participate in the construction of hydroelectric power stations in the neighboring countries, but the initiative has sparked protests in several countries. In the photo, young women walk on the river bank in Ishim, Astana.

The development and utilization of cross-border rivers has attracted increasing attention. The transfer project in Xinjiang has brought the attention of surrounding countries; Kazakhstan has sent bilateral agreements to China several times through diplomatic channels:

1. Strengthen the research on international laws, especially laws related to water. Based on the principles, application and conflict-solving procedures in international water laws, China analyzed and identified the principles that should be applied in the China-Kazakhstan cross-border river agreement.

2. Listen to suggestions from different sides, especially from downstream countries. Based on specific conditions and the China-Russia Eerqisi and Heilongjiang River Water Resource Comprehensive Utilization Report, China proposed two versions with relative explanations for the China-Kazakhstan Cooperation Agreement on Utilization and Protection of the Cross-border River, which aligns with the interests and pursuit of Kazakhstan.

3. Launch the Khorgos River Joint Water Transfer Project. The Khorgos River, 148 km long, originates from Mount Tianshan and flows through an area of 1605.6 m^2; the average flow every year is 540 million m^2. The east side of the river lies in the Xinjiang Province of China, and the west side in the Panfilov area of Kazakhstan. The project is located in an outlet of the Khorgos River and is the first international project on a cross-border river. Both countries have already built many transfer water projects to utilize the water resource. But, due to the lack of dams, the facilities were often damaged by flood and often caused difficulty in irrigation. After the construction of the joint project, agricultural irrigation, industry and living water can be ensured and the local economy can be better developed.

4. Strengthen bilateral cooperation proposals and procedures. China proposed to Kazakhstan specific content and principles on cooperation, including water sharing for the Ili and Eerqisi, information sharing on pollution, and cooperation on ecological protection, flood prevention, electricity generation, fishing, and research. The scope and regulations of information exchange were also listed. An institution managing the water resources should be set up.

POSSIBILITY OF FUTURE CONFLICTS

The first question is how to solve the water deficit. Based on the economic development of the two countries, the national water resource deficit by 2030 may reach 14 billion m2 in Kazakhstan and 40 billion in China, influencing the value of gross output by more than RMB 200 billion and causing 70 million people to have difficulty in water access every year. Although the solution for water deficit is applied, the strength and speed can be very different in all kinds of areas.

The second question is how to find the most effective solutions for the security of water resources through water transfer projects; how to reduce the centralized style of production in agriculture; how to increase utilization efficiency; and how to reduce pollution.

Third, the mode of cooperation should be decided. Currently, upstream and downstream countries often opt for bilateral cooperation. However, China and Kazakhstan should take into consideration Russia, Uzbekistan and Kyrgyzstan, which may also propose items to China. In August 2013, China and Russia cooperated in fighting floods and providing relief along the Heilongjiang River. This mode was appreciated by the international community. Choosing the mode of bilateral or multilateral cooperation should be unified.

The fourth question is to propose water resource cooperation supported by technology. Both countries should invest in advanced facilities and in cultivating in quality talent. A cross-border river circumstances inspection network should be set up. As a large upstream country, China should provide more investment and technology support so as to sustain information exchange and cooperation with neighboring countries.

Fifth, ecological cooperation should be launched. Kazakhstan enjoys rich underground water resources and iceberg resources, but is short on development and utilization. In March 2013, Kazakhstan proposed to use a national foundation to participate in the construction of hydropower stations in neighboring countries. But the participation aroused protest from some countries. China should take advantage of the foundation to launch technological research and development around water resources, so as to benefit both countries.

Sixth, the benefits of Kazakhstan should be considered and a compensation system should be set up. Cross-border rivers are of significance to Kazakhstan, which pays more attention than China to water resources. The lessons learned from the overused Aral Sea caused Kazakhstan to focus on the utilization of the Ili and Eerqisi Rivers by China. Therefore, China should consider the interests of Kazakhstan and build an interest-sharing and compensation system. A sincere attitude of cooperation is important to both countries, which can further strengthen and develop neighborly relations.

To summarize, conflicts on cross-border rivers are an issue of economics, but not only; there are also political, social and environmental factors. Kazakhstan will pay more attention to the utilization of water resources following the development of the economy. The issue of water-resource utilization can be a hot spot in bilateral cooperation, along with mining, oil, and military cooperation.

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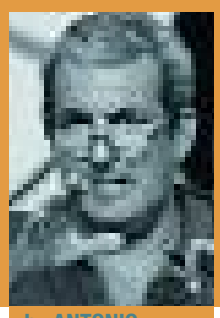
A matter of life and death: a survey of conflicts over "blue gold"



by ANTONIO GALDO

Aswan, Egypt. The temple of Isis is reflected in the waters of the Nile.

Water, bloody water. Conflict and geopolitical tension over control of this precious natural resource – it's no accident that water is called "blue gold" – is on the rise. The latest flashpoint is on the banks of the Nile, the longest river in the world after the Mississippi-Missouri, with a drainage basin that spans 10 different countries: chiefly Egypt, but also Sudan, Ethiopia, Eritrea, Kenya, Uganda, Tanzania, Rwanda, Burundi and the Democratic Republic of Congo. The Ethiopian Government, capitalizing on the weakness of its counterpart in Cairo, has begun constructing the Grand Renaissance Dam on the Nile – an enormous project costing $4.2 billion that will generate electricity to be exported elsewhere in Africa. For Ethiopians, the dam is extremely important: not only will it enable better use of river water in local agriculture, it will also make Ethiopia an energy exporter. However, since the British withdrawal, the Nile has been seen as a kind of private fiefdom of the Egyptian government. Lest we forget, Egypt was founded 5,000 years ago around the wetlands of this river, and the country has always held fast to Herodotus's definition of it as "the Gift of the Nile." As far as Egypt is concerned, the Nile is thus strictly off limits; furthermore, the deviations involved in the Ethiopian dam project will translate, over the five years of construction, into about 20 percent less water coming into Egypt. Since Egypt is dependent on the river for 97 percent of its water, it is clear that a significant drop in Nile water levels would have catastrophic consequences for the local economy. Shortly before he was unceremoniously ejected in a military coup, Egypt's President Mohammed Morsi shot this warning at the Ethiopians: "If the Nile is diminished by one drop, then our blood is the alternative. All options are open to avoid this threat to our security becoming reality."

While war between Ethiopia and Egypt is, for now, just a possibility, there are other parts of the world where tensions are running much higher and armies have already been deployed to protect water resources

According to studies by the Pacific Institute in Oakland, California, a research center specializing in environmental sustainability and especially in water usage, between 2010 and 2013 there were a total of 41 local wars over water: one in Oceania, six in Asia, eight in Latin America, 11 in Africa and 15 in the Middle East. In other words, such wars broke out in almost every part of the world. Water is being used as a weapon even in areas threatened by the advance of Islamic terrorism: in Afghanistan, for example, the Taliban has cut off the water supply to girls' schools.

Water wars are not only caused by strategic control of sources, but also by the scarcity of the "blue gold" that we in the West so often waste with our consumer lifestyle. Globally, there are currently 1.2 billion people – a fifth of the total population – living in areas where water is in short supply, and this figure could double by 2025, partly because of current demographic trends. A further 1.6 billion people have to ration their water because they are served by substandard infrastructure or because of regular supply issues. In addition, Africa faces the problem of cycles of drought that result in mass famines. In these areas, lack of water is an endemic problem and has a negative effect on health and food security. According to a report published by the UN Food and Agriculture Organization, between 2010 and 2012 famines killed 260,000 people in Somalia, about half of whom were children under five years old. In terms of health concerns, in the southern hemisphere the main victims of water shortages are children, with 1.8 million under-five-year-olds dying each year from illnesses including typhoid, cholera, dysentery and gastroenteritis – a heartbreaking loss of life.

The risk of conflict over water is thus higher in poorer countries and – as in the case of China, which is actually self-sufficient in water – feeds tensions between the north and south of every country. Even in the United States, where we certainly cannot imagine seeing citizens go to war over water supplies, there has been an exponential rise in disputes and administrative conflicts between states.

The United States holds the world record for water consumption per capita, at 1.58 billion cubic meters per year

Just five states – California, Idaho, Colorado, Texas, and Illinois – consume 30 percent of surface water. This results in continual legal battles with representatives of other states, who feel aggrieved at this unfair distribution of resources. In turn, this has led to the spread across the U.S. of campaigns to save water, which is described as a precious resource but also a source of possible conflict. Indeed, it is the U.S. and the Barack Obama administration that is watching developments along the Nile between Ethiopia and Egypt with the most interest. America is well aware of the explosive potential of these seemingly local conflicts, and regards them as threats to global security. A report by the U.S. State Department published several weeks ago asserts that "the number of conflicts over water around the world is set to increase because of population growth, along with declining drinking water to sustain it." In addition, "floods, shortages or low-quality drinking water combined with poverty, social tensions and weak governments and leadership will contribute to a level of instability that could lead to the collapse of numerous states." In such conditions, the State Department's report talks openly of the possibility of WWs, "Water Wars."

For Americans – and us Westerners in general – there is a precedent for water wars that sends shivers down the spine. The Middle East conflict – the mother of all wars of the latter 20th century – and all its secondary effects on the development of terrorism originated over control of the Jordan River basin and its sources. As Ariel Sharon, a general during the famous Six-Day War who would go on to be prime minister of Israel, wrote in his autobiography, "disputes over borders between Israelis and Palestinians have been, and will be, extremely important; but disputes over water have been, and will be, a matter of life and death." Well, we were warned.

Antonio Galdo recently published *L'egoismo è finito* (Einaudi) and runs the website www.nonsprecare.it

Wonder or ecological disaster? Facing Jordan's water crisis

by DANIEL ATZORI

Looking at the Jordan River, I was profoundly moved by the mystical atmosphere that pervades the surroundings. It really seems a place out of space and time, where miracles are still possible. This is one of the world's most sacred waterways, which flows from the heights of Mount Hermion, in the north, to the depths of the Dead Sea, in the south, along the rift between two tectonic plates. The Jordan valley is one of the cradles of human civilization, since its waters provide irrigation to the region's agriculture from time immemorial. It has been inhabited since at least the fifth millennium B.C. and is mentioned several times in the Bible. In the Book of Genesis, it is written: "Lot looked around and saw that the whole plain of the Jordan toward Zoar was well watered, like the garden of the Lord, like the land of Egypt" (13:10). The fertile valley which runs for about 120 kilometers between Lake Tiberias (the Sea of Galilee) and the Dead Sea is known by the Arabs as the *Ghor*; the River Jordan was known as *nahr el-sheriat el-kebir*, which could be translated as "the great drinking place." The waterway has, obviously, an enormous spiritual importance for Christians, since here John the Baptist preached and baptized Jesus. As Rachel Havrelock's *River Jordan: The Mythology of a Dividing Line* shows, here symbols and politics profoundly overlap. Reviewing the book, Harold Brodsky, of the University of Maryland, writes that these pages "successfully demonstrate that the Jordan can be a border, a place of spiritual transition, a divisive barrier, a subject of fantasy, a wonder, or an ecological disaster."

The headwaters of the Jordan near Mount Hermon in the Golan Heights, Israel.

At the same time, when I saw the Jordan River, I was surprised to see such a tiny stream of water. Indeed, huge withdrawals for irrigation have contributed to reduce the volume of its waters. Today its basin, which has been estimated to drain 18,300 km^2, includes the countries of Jordan, Syria, Lebanon, Palestine (the West Bank) and Israel.

For decades, the competition over the river's water resources has been an important element in the conflicts of the area

Then, in 1994, Jordan and Israel signed a peace agreement, known as Wadi Araba, which states, in Article 3, paragraph 6: "The parties recognize that their water resources are not sufficient to meet their needs. More water should be supplied for their use through various methods, including projects of regional and international cooperation."
The river, which now constitutes part of the border between the Hashemite Kingdom of Jordan and Israel, is not sufficient to quench the riparian countries' thirst. In Jordan, which is already one of the poorest countries in the world in terms of water resources per inhabitant, the situation risks worsening due to the influx of Syrian refugees. The balance between water resources and population has been strained by population growth, and the arrival of an estimated 500,000 people escaping from the civil war is further stretching the supply.
One year ago, the area which now hosts the Syrian refugee camp of Zaatari was just a desert; today, it is the fourth-largest city in Jordan, with an estimated population of 120,000 inhabitants.
As Hazim el-Naser, the Jordanian minister of water and irrigation, declared, "We're on the edge of a cliff, and if it continues this way, we will fall," adding, "we are in a water crisis, and it is spreading." Water scarcity threatens the Jordanian economy as a whole, and ingenious solutions are needed. That is why the Hashemite Kingdom is now pumping up so-called "fossil water": His Majesty King Abdullah II recently inaugurated the $990 million Disi Water Conveyance Project, with which 100 million cubic meters of water per year will be allocated across the country. The water will be transported through a 325-kilometer pipeline that connects the Disi aquifer, situated in the desert of southern Jordan on the border with Saudi Arabia, with the capital, Amman.

There is a striking similarity between this water and oil; both of them are considered "fossils"

Disi's aquifer formed about thirty thousand years ago, and its waters, being a finite resource, are not renewable. A question is often raised: is it ethical to deplete water resources stored eons ago, depriving the future generations of this gift?
In the coming decades, new technologies will, one hopes, make seawater desalination, which is now very energy-intensive, more convenient. Indeed, at the same time, Jordan is seeking bids for a project to desalinate Red Sea waters in order to refill the Dead Sea. The hope is that, by combining the use of fossil and desalinated water, Amman will manage to solve its chronic water shortage. Were Jordan to be successful, it would become a precious example for all the countries that are suffering from this problem. The new projects well suit King Hussein's vision, defined in his website (http://www.kingabdullah.jo/) as "a thriving and successful economy at the heart of a peaceful, prosperous and democratic region." Joint projects among the Jordan River's riparian countries could, indeed, provide systemic solutions to address water scarcity and also contribute to the stability and prosperity to a region which could become, once again, known not for its problems but for its inestimable wonders. ■

Daniel Atzori has been a Senior Researcher at the Fondazione Eni Enrico Mattei (FEEM) and he is currently Editorial Team Coordinator of the magazine *Papers of Dialogue*.

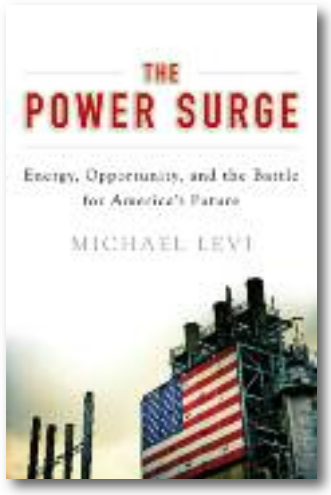
by CARLO ROSSELLA

The power surge

It is far from easy to find a specialized, high-quality book, aimed at a particular audience but written in simple language, with a strong journalistic flavor, that is clearly intelligible to the average reader. Yet Michael Levi has written just such a work. Entitled *The Power Surge*, it addresses "energy, opportunity, and the battle for America's future," as its subtitle indicates. It is a Council of Foreign Relations volume, published by Oxford University Press.

Dr. Levi is a Senior Fellow of the Council on Foreign Relations and Director of the Program on Energy Security and Climate Change. He is a specialist in climate change, energy security, arms control, and nuclear terrorism. Dr. Levi has testified before the United States Congress as a scientific expert, and is one of the most highly regarded consultants in the political and business worlds.

In *The Power Surge*, the author provides an intriguing picture of the rapid changes taking place in the United States energy landscape, including oil research, gas production, renewable energy, and declining consumption. He identifies the consequences of this evolution for the economy, national security, and the environment.



Title: The Power Surge
Author: Michael Levi
Publisher: Oxford University Press
Info: 2013, 260 pages
Price: $15.13

"Everything we once knew about American energy seems to be changing," writes Levi, adding, "The United States can strengthen its economy, improve national security, and confront climate change if it intelligently embraces the historic gains unfolding all across the energy landscape."

Levi leads the reader through the energy revolution and the opportunities it offers. This is an entirely non-partisan depiction, a true summary of all useful and possible energy policies. Energy will be placed squarely at the center of the U.S. economic and political debate in the coming years. Anyone with an interest in this subject, so essential to our lives, would be well-advised to read Levi, since, as Daniel Yergin puts it, he "captures the turning point in the energy situation in America and the world."

Levi masterfully provides practical examples, linking them to the general trend, as in the history of fuel consumption in cars. Gas-guzzlers such as the Hummer, sales of which fell from 70,000 in 2006 to 30,000 in 2013, have given way to no-waste vehicles. And all because General Motors and the other major automotive groups understood the need to cut fuel consumption, both for economic reasons and in response to the new philosophy of saving energy and combating atmospheric pollution.

Green ethics, the fight against pollution, and decreased consumption have been a positive force in the U.S. economy, considerably reducing its reliance on the energy-exporting countries. American consumers are more aware of both the price of fuel, which is now higher, and the consequences of fuel waste by vehicles with large engines. The big auto groups are now directing their research efforts towards hybrids and even electric vehicles. European manufacturers such as BMW have clearly made more progress in this field, but the road transport revolution will inevitably have a significant effect on the U.S., given its advantages and political acceptability.

Carlo Rossella is a journalist and executive. He has been the head of *La Stampa*, *Panorama*, and TG1 and TG5 (the TV news programs). He is currently chairman of Medusa Film, the production company of Mediaset.

The water crisis

Title: Water, Peace and War
Author: Brahma Chellaney
Publisher: Rowman & Littlefield Publishers
Info: 2013, 424 pages
Price: $36.40

This study focuses on the profound global impact of the water crisis, which poses a threat to peace and international security. Despite this fact, water is the most undervalued of all resources. One statistic should make us stop and think: the retail price of bottled water is already higher than the international spot price for crude oil. The difference is that, unlike oil, water cannot be replaced by other resources.

A difficult choice

Title: Oil and Water: a novel
Author: Mei Mei Evans
Publisher: University of Alaska Press
Info: 2013, 267 pages
Price: $12.66

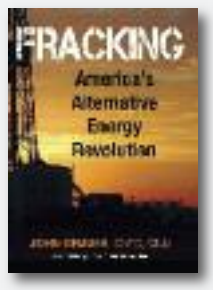
What happens when the American Dream runs up against a nation's dependence on fossil fuels? This is the question at the heart of *Oil and Water: A Novel*. The book tells the story of an oil leak from a tanker that threatens the entire Gulf of Alaska. It is a provocative look at the choice between environmental security and economic survival.

A geopolitical analysis

Title: Energia e Ambiente ieri, oggi e domani
Author: Augusto Leggio
Publisher: Narcissus.me
Info: 2013, 368 pages
Price: €7.99

This book offers a survey of energy and the environment, as well as detailed analysis of energy waste, the pollution of the earth and the atmosphere, and the resulting geopolitical threats. Starting with a history of fossil fuels and renewable energy, the author develops his theory that the hoarding of energy reserves was behind the wars of the 20th century.

The impact of fracking



Title: Fracking: America Alternative Energy Revolution
Author: John Graves
Publisher: Safe Harbor
Info: 2013, 300 pages
Price: $16.20

John Graves provides a detailed account of the history of the process of deep hydraulic fracturing and the people and communities affected by it. As well as increased reserves of gas and oil, the advent of shale gas has also brought about reduced imports and increased tax revenues in the United States. The book also provides a balanced view of the environmental issues at stake.

MARKET TRENDS

Geopolitics return to center-stage

Crude prices rise on fears of U.S. intervention in Syria and ongoing Libya crisis

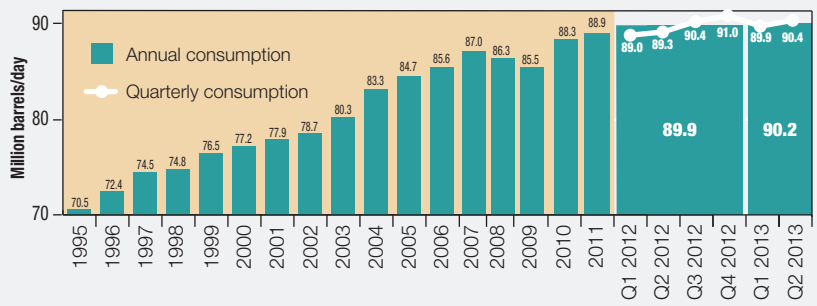
Oil prices

Following the lull in spring – when the price of Brent was steady at around $100/barrel – recent months have made the market "heat up again" because of geopolitical tensions, driving up crude prices to $115/barrel in August. In addition to the Iranian embargo, in place since early 2012, other causes for concern are the Libyan crisis – which removes 1 million of barrels per day (mbpd) of crude from the market – as well as the ongoing (and now structural) problems in Nigeria, where losses have doubled since a year ago, and the slowing ramp-up of Iraqi production, caused by continuous attacks on the Kirkuk-Ceyhan pipeline in the north of the country. The Syrian issue has also become more complicated, nearly leading to a controversial U.S. military intervention that is yet to be ruled out and that could bring about more widespread conflict in the region. Therefore, while oil supplies outstripped demand by some 0.8 mbpd in the first half of the year, the figures have been much tighter since July, at just 0.1 mbpd. The physical market has seen falling crude stocks in both Europe and the U.S., while effective capacity among Gulf OPEC countries (Saudi Arabia – accounting for 90 percent – plus Kuwait, United Arab Emirates and Qatar) is down to a little over 2 mbpd.
This has meant that Mediterranean refiners have had to make do with an increasingly "short" supply, accentuating the reliance on imports of Russian crude. Urals prices consistently traded at a premium to Brent during July and August, putting regional refining margins into the red. The current issues add to a pre-existing structural decline of Russian crude in the Mediterranean, caused by changes in Russia's export routes. The country's trade is now oriented more toward higher added-value destinations – especially Asia, which has doubled its Russian import volumes in the last three years.
The risk of crude oil reaching $120/barrel has reopened debate over a possible release of strategic reserves by International Energy Agency (IEA) countries, as occurred in June 2011 in the middle of the Libyan crisis. The market has undergone several changes since then, especially with regard to the role of the U.S., making potential recourse to IEA reserves less important. In 2011, in fact, the decision was taken to release 60 million barrels of strategic reserves, 30 million barrels of which came from U.S. government stocks. The U.S., which still holds more than 50 percent of IEA strategic reserves, has not yet reconstituted the previous volumes, since the escalation of domestic production has greatly reduced the country's dependence on foreign crude imports. International trade of crude oil has felt the effects of this change and the role of leading consumer has now passed to China, whose policies are certainly less transparent and predictable for the international market. For the moment, then, the IEA considers global supply to be adequate and sees no need for coordinated intervention.
Leading analysts generally agree that the current geopolitical tensions are only temporary, and are expecting to see prices cool from late 2013 onwards.
This will be facilitated, on the supply side, by continued growth in North American production and by Saudi Arabia's interventions and, on the demand side, by lower spending on scheduled refinery maintenance in the U.S. and Europe.

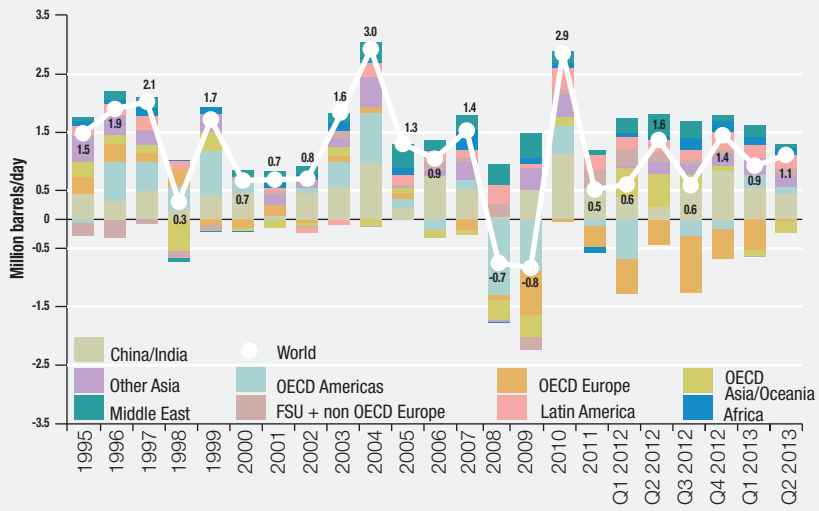
Oil demand

The second quarter of 2013 saw year-on-year global oil demand growth of 1.1 mbpd, reaching 90.4 mbpd – a slight increase on Q1 year-on-year figures (+0.9 mbpd). Among Organization for Economic Co-operation and Development (OECD) countries, the decline in European demand slowed between Q1 (-3.9 percent) and Q2 (-0.2 percent), while middle distillates saw fresh growth (-1.6 percent in Q1 to +2.2 percent in Q2), in line with the euro zone's gradual recovery from the recession. Gasoline consumption, however, continued to fall (-6.7% in Q1, -4.5% in Q2), due to the impact of dieselization, improving fleet efficiency and persistently high pump prices in the main consumer countries (France, Italy, Germany, Spain and the U.K.). Unlike Europe, figures in the OECD Americas region remained positive thanks to the improving economy. In the U.S., fuel consumption increased by 2.8 percent in Q2 as a result of rising business activity and commercial transportation. Unlike diesel, there was no sign of recovery for gasoline in the first half of 2013 (-0.7 percent in Q1 and -0.6 percent in Q2), thus confirming the structural nature of the trend developing in the U.S. since 2006. The negative impact on consumption of improved fleet efficiency has more than neutralized the positive impact of pump prices and the fall in the unemployment rate since 2012. Non-OECD consumption continues to drive the increase in world oil demand, despite the gradual slowdown since late 2012 (Q4-2012: 3.9 percent; Q1-2013: 3.6 percent; Q2-2013: 2.6 percent) caused by a marked deceleration in economic growth.
Consumption of oil products in China also shows a progressive decline since Q4-2012, in line with the January-June fall in the country's Producer Manager Index (PMI – the index of manufacturing and services sector orders, which anticipates economic performance) and the government's decision to slash the 2013 growth target from 7.5 percent to 7 percent.

GLOBAL CONSUMPTION

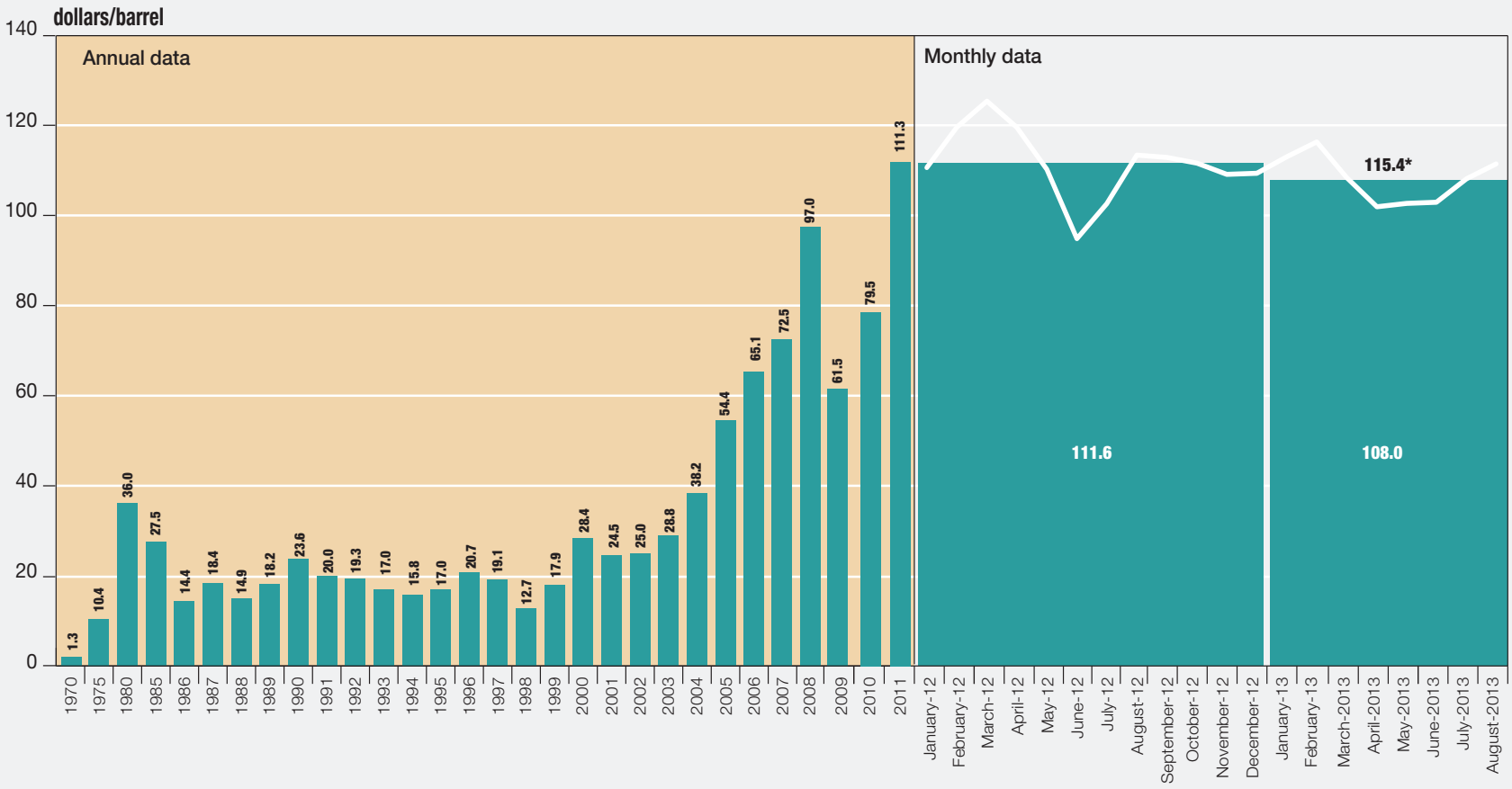


VARIATION IN GLOBAL CONSUMPTION BY AREA



Source: Eni's processing of International Energy Agency data; change vs the same period of the previous year

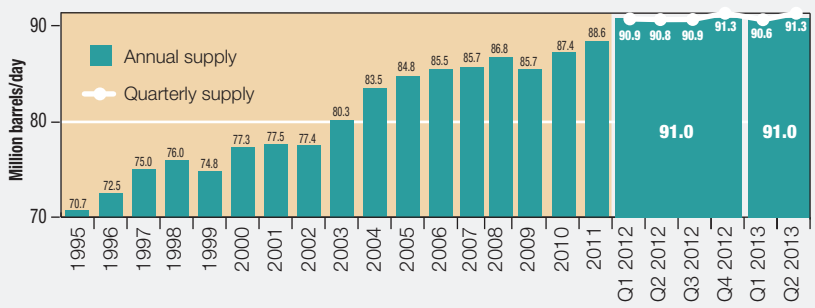
BRENT PRICE



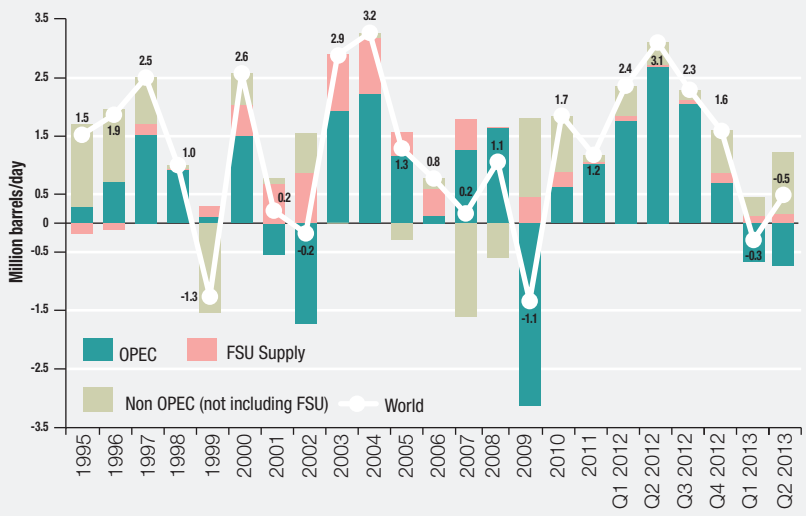
** last updated August 30, 2013*

Source: IEA, spot price of Arabian Light (1970-1985); IEA, spot price of Brent (1986-1987); Platt's, spot price of Brent Dated (from 1988)

GLOBAL SUPPLY



VARIATION IN GLOBAL SUPPLY BY AREA



Source: Eni's processing of International Energy Agency data; change vs the same period of the previous year

Oil supply

Global oil supply in Q2-2013 recovered slightly compared to the start of the year, reaching 91.4 mbpd. However, only the non-OPEC countries saw growth. North America achieved the greatest increase (+1.2 mbpd), as U.S. crude production hit 7.3 mbpd – the highest since the late 1980s – largely thanks to the development of tight oil concentrated in Texas and North Dakota. Canada also saw continued growth, reaching a new record high mainly due to its oil sands projects. There was also supply growth for the other large non-OPEC producers, Russia (+0.2 mbpd) and China (+0.1 mbpd). South Sudan resumed production in recent months, despite lingering and partially unresolved problems over transport to the north. The situation in Brazil has improved as early-year production problems in the pre-salt fields of the Campos Basin have eased up.

Meanwhile, OPEC's crude oil output continues to fall (-0.7 mbpd). Except for the small gains made by Kuwait and the U.A.E., all the OPEC countries' volumes were down.

The situation within the OPEC countries further deteriorated during the summer. In Libya, strikes and clashes between various militia groups led to the closure of export terminals, refineries and fields. Moreover, the major pipelines carrying crude oil to the port of Zawiya and to Mellitah had to be closed, resulting in a shutdown of the Sharara and Elephant fields. In August, average production was estimated at about 0.6 mbpd, hitting lows at the end of the month of 150 kbpd – only 10 percent of the country's production capacity and the lowest output since October 2011, the month of Gaddafi's death. Production is stagnant in Iraq after two years of strong growth. In the north, the Kirkuk-Ceyhan pipeline continues to suffer attacks, and there is ongoing tension between the central government and the autonomous Kurdish government, causing the independent region's exports to fall to the lowest levels for the last five years. Nigerian production is also slowing, especially in onshore fields. Bonny Light has been under *force majeure* since April, while the Escravos, Forcados and Brass River suffer constant sabotage.

Oil

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