A communal well at a Malawi village was contaminated in January by floodwaters that swept away homes and crops.

Over the last few decades, as scientists have intensified their study of the human effects on climate and of the effects of climate change on humans, a common theme has emerged: in both respects, the world is a very unequal place.

In almost every instance, the people most at risk from climate change live in countries that have contributed the least to the atmospheric buildup of carbon dioxide and other greenhouse gases linked to the recent warming of the planet.

Those most vulnerable countries also tend to be the poorest. And the countries that face the least harm — and that are best equipped to deal with the harm they do face — tend to be the richest.

To advocates of unified action to curb greenhouse gases, this growing realization is not welcome news.
“The original idea was that we were all in this together, and that was an easier idea to sell,” said Robert O. Mendelsohn, an economist at Yale. “But the research is not supporting that. We’re not in it together.”

The large, industrialized countries are more resilient partly because of geography; they are mostly in midlatitude regions with Goldilocks climates — neither too hot nor too cold.

Many enjoy gifts like the thick, rich soil and generous growing season of the American corn belt or the forgiving weather of France and New Zealand.

But a bigger factor is their wealth — wealth built at least partly on a century or more of burning coal, oil and the other fossil fuels that underlie their mobile, industrial, climate-controlled way of life.

The United States, where agriculture represents just 4 percent of the economy, can endure a climatic setback far more easily than a country like Malawi, where 90 percent of the population lives in rural areas and about 40 percent of the economy is driven by rain-fed agriculture.

As big developing countries like China and India climb out of poverty, they emit their own volumes of greenhouse gases; China is about to surpass the United States in annual emissions of carbon dioxide.

But they remain a small fraction of the total human contribution to the atmosphere’s natural heat-holding greenhouse effect, which is cumulative because of the long-lived nature of carbon dioxide and some other heat-trapping gases. China may be a powerhouse now, but it has contributed less than 8 percent of the total emissions of carbon dioxide from energy use since 1850, while the United States is responsible for 29 percent and Western Europe 27 percent.

Disparities like these have prompted a growing array of officials in developing countries and experts on climate, environmental law and diplomacy to insist that the first world owes the third world a climate debt.

The obligation of the established greenhouse-gas emitters to help those most imperiled by warming derives from the longstanding legal concept that “the polluter pays,” many experts say.

“We have an obligation to help countries prepare for the climate changes that we are largely responsible for,” said Peter H. Gleick, the founder of the Pacific Institute for Studies in Development, Environment and Security in Berkeley, Calif. His institute has been tracking trends like the burst of new desalination plants in wealthy places running short of water.
“If you drive your car into your neighbor’s living room, don’t you owe your neighbor something?” Dr. Gleick said. “On this planet, we’re driving the climate car into our neighbors’ living room, and they don’t have insurance and we do.”

Around the world, there are abundant examples of how wealth is already enabling some countries to gird against climatic and coastal risks, while poverty, geography and history place some of the world’s most crowded, vulnerable regions directly in harm’s way.

Here are four views of the climate divide.

**Prone to Drought, and All but Unable to Predict the Weather**

BLANTYRE, Malawi, March 29 — Twice a day, 25-year-old Harold Nkhoma checks a series of gauges at the government’s weather station here in Malawi’s second-biggest city.

He skips the barometer because its light doesn’t work and he can’t read the figures. He has waited six months for new batteries.

He ignores the evaporation pan designed to show how quickly water is absorbed into the soil. Peeled-off paint and missing wire mesh have left it useless. And he bypasses the glass sphere that measures the duration of sunshine by burning marks on paper strips. It has been out of paper for four years.

His supervisor, Werani Chilenga, is disgusted. Broken equipment, outmoded technology, slipshod data and a sparse scattering of weather stations are all that his national agency can manage on a $160,000 budget.

“We cannot even know the duration of sunshine in our country for four years, so how can we measure climate change?” said Mr. Chilenga, a meteorological engineer. “Oh, oh, it is pathetic!”

The lack of meteorological data is just one challenge as Malawi struggles to cope with global warming. Add to that a lack of irrigation; overdependence on a single crop, maize; shrinking fish stocks; vanishing forests; and land degradation.

Last March, Malawi, which has a population of 14 million people and is one of the world’s poorest countries, identified $23 million worth of urgent measures it should take in the next three years. It delivered them to the United Nations program that helps poor nations deal with climate change.

A year later, the government is still negotiating with donors. “It is sad that up until now we have not gotten the monies that have been talked about,” said Henry Chimunthu Banda, the minister of environmental affairs. That is not to say Malawi is standing still. The government is moving toward bigger grain reserves,
changes in agricultural practices and construction of a new dam. Nine out of 10 Malawians are subsistence farmers.

Austin Kampen, 39, is an early adapter. A nonprofit group last year gave him hoses and a huge bucket — a rudimentary but effective crop sprinkler system.

He plants a variety of maize more likely to survive shorter growing seasons and backs it up with cotton, vegetables, potatoes and cassava.

He still lost his entire harvest in January when the river overflowed after a week of nonstop rain, submerging his seven-acre field and leaving 75 of his neighbors homeless. Still, he said, he will manage to plant anew this season.

Another farmer, Jessie Kaunde, also aims for resilience. But her bravest effort failed.

Armed with a $68 loan, she dug two fish ponds in 1999 behind her house north of Blantyre. Since drought struck three years ago, they are nothing but giant grassy pits.

“I am really disappointed,” she said.

One reason is that other farmers have planted by the river that fed her ponds, causing the riverbanks to cave in and disrupt the water flow. Such planting is illegal but enforcement is weak, said Everhart Nangoma, an environmental specialist formerly with CURE, a nonprofit group focusing partly on climate change.

“Malawi is getting ready, but we are not there,” Mr. Nangoma said. “We are not ready at all.” - SHARON LAFRANIERE

**Prone to Drought, but Moving Ahead on Desalination**

PERTH, Australia, March 27 — Looking out over a sparkling blue bay on Australia’s west coast, Gary Crisp, an alchemist for the new century, saw an ocean of drinking water.

Behind him was an industrial park filled with tanks, pipes, screens, filters and chemicals for converting seawater into drinking water — 17 percent of the water supply for this city of 1.5 million people.

As the world warms and clean water becomes a prized commodity, the Perth Seawater Desalination Plant is using the renewable resources of wind and ocean to produce it, along with a finite resource that is less available in many other countries: money.
The $313 million plant, among the largest in world (behind giant plants in Israel and the United Arab Emirates), opened in November and is already running at capacity, producing up to 38 million gallons of water a day, nearly enough to fill 100 Olympic-size swimming pools.

The seawater is sucked into the plant through a pipeline whose mouth is 200 yards offshore. Once inside, it is filtered through fine membranes in a complex process called reverse osmosis.

About half the water is purified and sent into the city water system to mingle with water from other sources. The salt remains in the other half, which is flushed back out to the ocean.

The plant is one of the newest in a rapid spread of desalination plants in countries that can afford them. Though the plants are expensive to build, water from them costs only $3.50 per 1,000 gallons. They are commonplace in the Middle East, where oil pays for water, and Southern California is home to many smaller plants. What sets the Perth plant apart is not only its size but its engine — wind power.

The plant is driven by power from 48 turbines in the Emu Downs Wind Farm, about 100 miles to the north, with a capacity of 80 megawatts of electricity, more than three times the needs of the plant. That avoids the trade-off at most desalination plants, which are powered by fossil fuels that produce greenhouse gases.

“We call it alchemy — converting wind to water,” said Mr. Crisp, the Perth plant’s principal desalination engineer.

The treated water offers people here in the world’s most arid continent “security through diversity,” in the local phrase, complementing dams, aquifers and recycling. Water conservation could be a powerful tool, but few politicians dare to suggest any measures more aggressive than limiting the use of lawn sprinklers — a privation Perth’s plant is helping to avoid.

Half the water used domestically in Perth goes to gardens, Mr. Crisp said; of the water used indoors, 30 percent goes into washing machines. Affluent suburbs use twice as much water as the city proper, he said.

Australia is suffering some of the worst droughts in its recorded history. Stream flows into dams in Perth have shrunk by two-thirds in the last 30 years, even as its population swells by more than 20,000 people a year.

Perth is talking about building one or two more plants in the coming years, and similar plants are in the early stages of development in Sydney and the town of Tugun in Queensland.
Having proved itself, the plant will have its official opening next month. Standing by the sparkling blue bay, people will be invited to drink from small plastic bottles bearing labels that read, “Limited edition desalinated water from the Perth Seawater Desalination Plant.” - SETH MYDANS

**At Risk From Floods, and Defenseless When the Rivers Rise**

DHANAUR, India, March 28 — Year after year, the Baghmati river swells with the rains and, rushing down from the Himalayas, submerges this back-of-beyond village into utter ruin.

Year after year, it sweeps away cattle and goats. It sends mud houses collapsing back into the earth. It kills dozens of people in and around Dhanaur, and that’s during a mild monsoon, like last year, when Pavan Devi’s 19-year-old son, Vikas Kumar, went to a communal toilet in the fields and was swept away by a fast-moving stream.

In 2004, the last major flood, the death toll stood at 351 in Bihar state, which is home to this village and many others sitting on some of the most vulnerable floodplains in India.

Their vulnerability is likely to grow. Since 1950, in concert with global warming, monsoon rains over India have increasingly come as heavy downpours rather than gentle showers, Indian scientists reported last year. That pattern is raising the risk of sudden floods.

Cities are prone to peril as well: In 2005, 37 inches of rain in 24 hours crippled the country’s commercial capital, Mumbai, killing 400 people.

The picture here in this destitute, crowded corner shows how ill-equipped India remains in dealing with that looming danger, despite its newfound prosperity. Nationwide, about 20 million acres of land are affected by floods each year, according to the government; they affect 4.2 million Indians each year on average, according to Columbia University.

Here in Dhanaur, for nearly three months of monsoon, everyone lives at the water’s mercy. The well-off save their firewood and food grains for the annual disaster. The poor beg and borrow to eat, and they camp out on higher ground in tents made of cement bags.

They bathe and defecate in the floodwater. They drink from it, too. Who can afford to boil it before drinking, a father of six named Hira Majhi asked. With prices more than doubling during the rainy season, there is never enough money for cooking fuel, and hand pumps are routinely submerged. Last year, after his 4-year-old son contracted black fever, a deadly disease endemic here, Mr. Majhi rowed for an hour, in a homemade canoe made of water hyacinth leaves. No government ambulances ply here.
The most vulnerable to these annual floods are those who sit lowest on the pecking order. Mr. Majhi, for instance, belongs to a low caste group so poor for so long that they are commonly known as musahars, or the rat-eaters. He is landless. He works on other people’s fields, usually only during the sowing and harvesting seasons. Because the land remains under water for so long, there is only one harvest each year. Floods and droughts hit families like his the hardest of all.

The measures taken by the government to adapt to the annual floods are rudimentary at best. Some parts of the road have been built with conduits underneath to let water pass, but the road itself is pocked with gaping craters, and locals say it is usually impassable for weeks at a time during the rains. No embankments have been built; construction upstream was suspended 30 years ago, though it is scheduled to resume later this year. Enterprising villagers have built bamboo bridges.

Last year, for the first time, the government put an early warning system into effect. Local officials went around with a bullhorn, on cycle-pulled rickshaws, warning of imminent floods. But there were no shelters to go to, except the local village school, where there was no drinking water or latrines.

In mid-March, the Baghmati rose up during an unexpectedly early spring flood. In less than a day, it wreaked havoc.

Sunil Kumar, one of the more well-to-do farmers here, lost three acres of wheat, a third of his annual income. He walked across his own soggy field and then across his neighbor’s, examining patches of barley and mustard and peas — all waterlogged and ruined.

“It is our misfortune living here,” he said. “There is no system of water control.”

SOMINI SENGUPTA

At Risk From Floods, but Looking Ahead With Floating Houses

MAASBOMMEL, the Netherlands, March 29 — Anne van der Molen lives on the edge of the River Maas, by definition an insecure spot in a country constantly trying to keep water at bay. But she is ready for the next flood.

Excited, even. “We haven’t floated,” she said of her house, “but we’re looking forward to floating.”

Her two-bedroom, two-story house, which cost about $420,000, is not a houseboat, and not a floating house of the sort common across the world. It is amphibious: resting on land but built to rise with the water level. It sits on a hollow concrete foundation and is attached to six iron posts sunk into the lake bottom. Should the river swell, as it often does in the rain, the house will float up
as much as 18 feet, held in place by two horizontal mooring posts that connect it to the neighboring house, and then float back down as the water subsides.

It is part of a new experiment in living. The 46 houses here are meant to address two issues at the heart of the housing debate in this low-lying, densely populated country, said Steven de Boer, a concept developer at Dura Vermeer, the company that developed the project. These are lack of space for new housing to meet a growing demand and the need to anticipate relentlessly rising sea levels and a heightened chance of flooding rains because of climate change.

Worries about water levels are not a hypothetical issue here in this village in Gelderland province, southeast of Amsterdam. In 1995, the Maas and other rivers overflowed their banks and breached the dikes, forcing 250,000 people to evacuate their homes. Now the dikes are higher, but with a possible sea-level rise of several feet within a century or so, much more is needed.

“All the universities are united in one big program with the government; we have a team of some 500 people working on climate-proofing the Netherlands,” said Pier Vellinga, a professor of climate change at the University of Amsterdam. “Whatever happens — Greenland melting or tropical storms surging on the Atlantic — we are here to stay. That is becoming our national slogan.”

That means developing new guidelines for building in flood-prone areas, introducing insurance for those who live in exposed places, building higher dikes and exploring ways for farmers to adapt to a new agricultural landscape.

For private firms, it means experimenting with new housing, as Dura Vermeer is doing here in Maasbommel. The company has also built a floating greenhouse near the Hague and, along with other firms, has received government approval to try other kinds of housing in 15 areas in the country at risk for flooding. Other proposals — for entire floating cities, for instance — are still preliminary, but are being talked about seriously as a possible way forward.

In Maasbommel, Mrs. van de Molen loves the feeling of almost being part of the river.

“All Dutch people have always had to fight against the water,” she said. “This is another way of thinking about it. This is a way to enjoy the water, to work with it instead of against it.” - SARAH LYALL

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