

Water Water Everywhere

Insights from South Asia into climate pressure on the Global South

Anthony Acciavatti & Sunil Amrith in Conversation

Yale University

Wellcome Collection

15 October 2025





Anthony Acciavatti, 'Groundwater Earth: The World Before and After the Tubewell,' Yale School of Architecture.



Anthony Acciavatti, 'Groundwater Earth: The World Before and After the Tubewell,' Venice Architecture Biennale,, Venice (Italy)



House

The House is a model of a sustainable living environment. It is designed to be a place where people can live in harmony with nature, using renewable resources and minimizing their impact on the environment. The House is built using natural materials and is designed to be energy-efficient, with a focus on natural light and ventilation. The House is also designed to be a place where people can live in harmony with nature, using renewable resources and minimizing their impact on the environment. The House is built using natural materials and is designed to be energy-efficient, with a focus on natural light and ventilation.





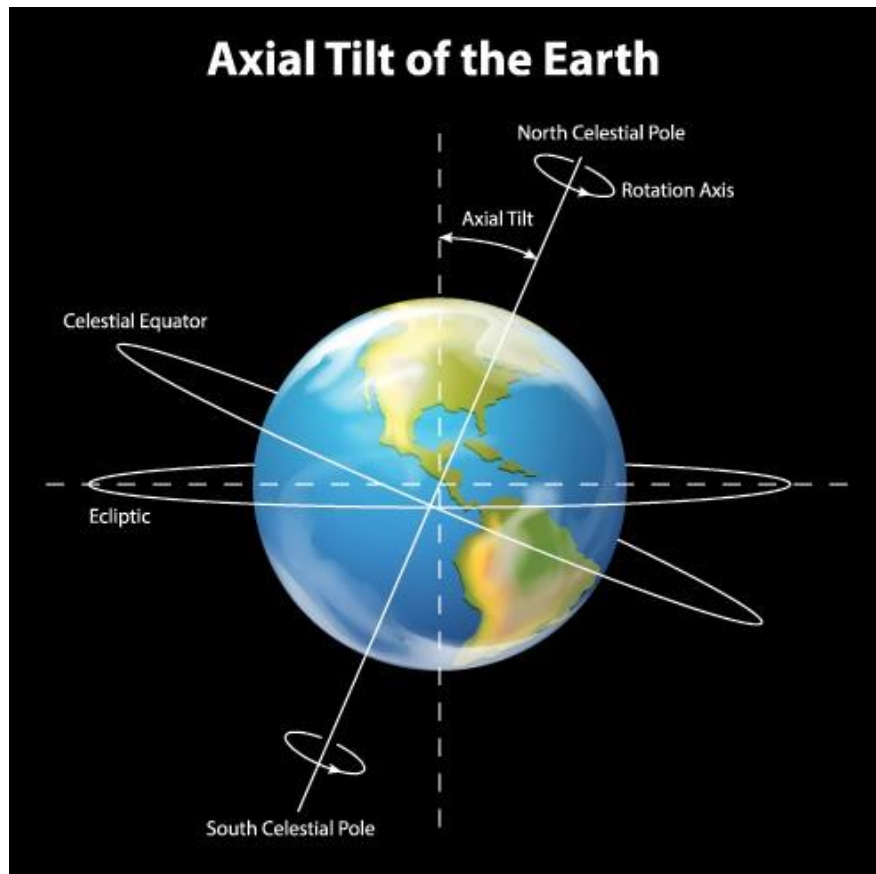
80cm

80cm

979 km³

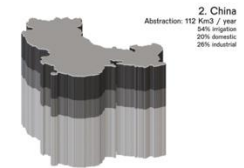
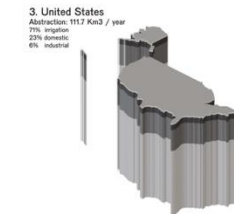
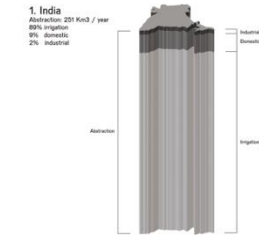
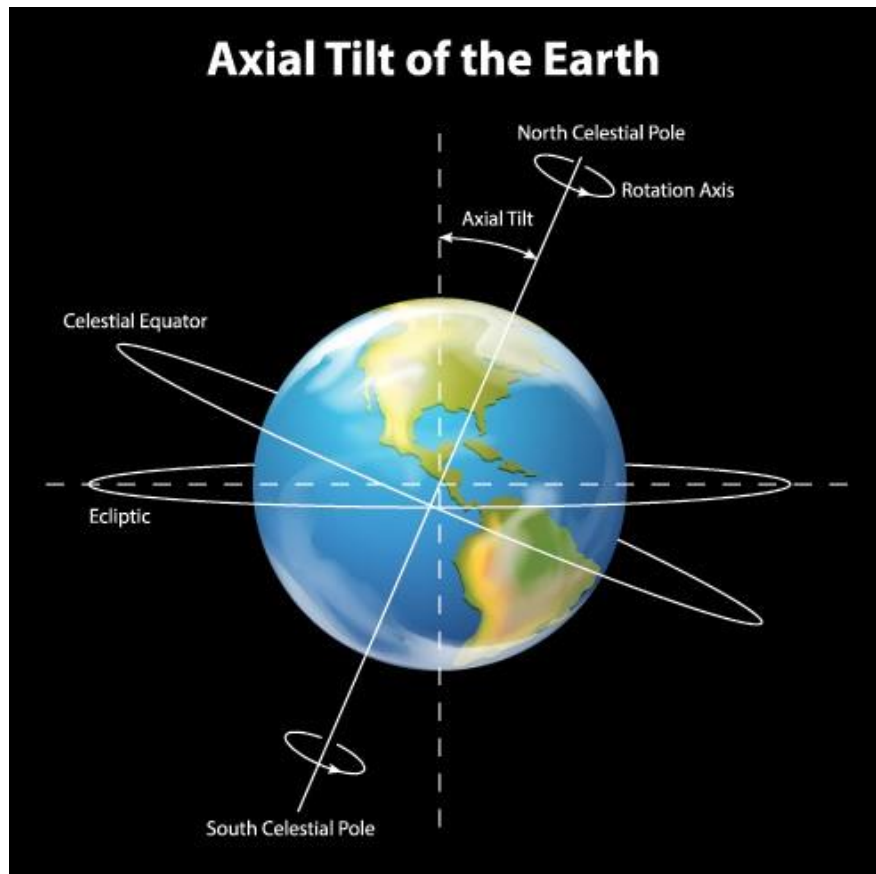
80cm

979 km³



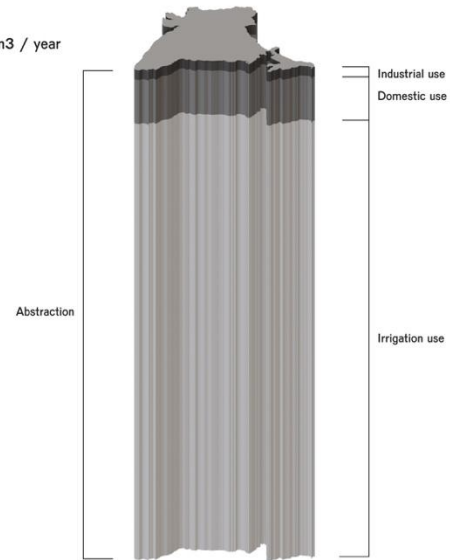
80cm

979 km³



1. India

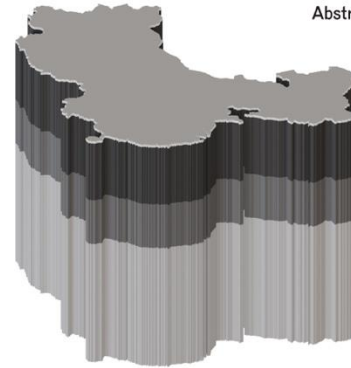
Abstraction: 251 Km³ / year
89% irrigation
9% domestic
2% industrial



539.5 km³

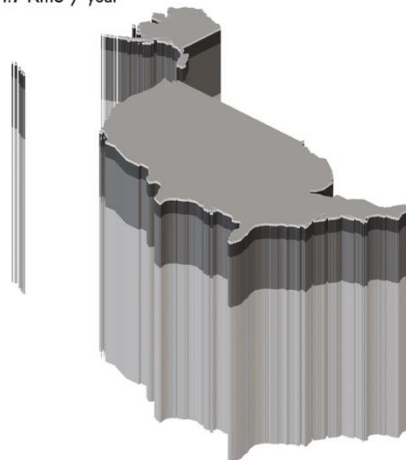
2. China

Abstraction: 112 Km³ / year
54% irrigation
20% domestic
26% industrial



3. United States

Abstraction: 111.7 Km³ / year
71% irrigation
23% domestic
6% industrial

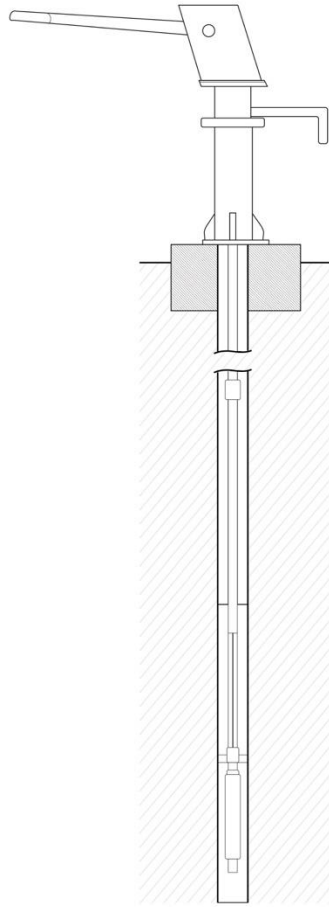


4. Pakistan

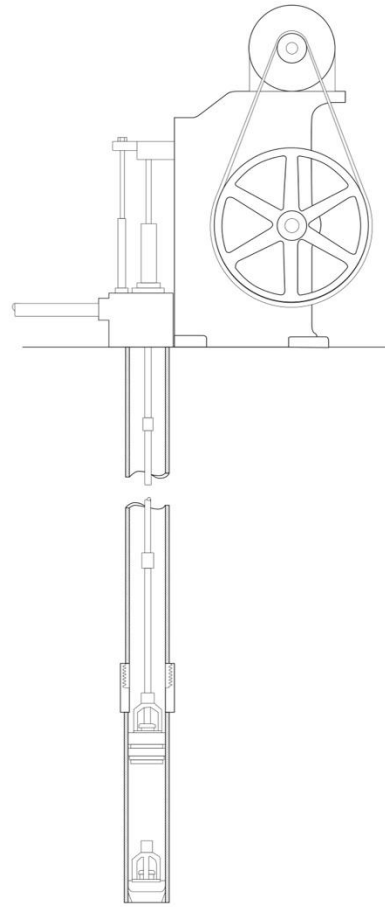
Abstraction: 64.8 Km³ / year
94% irrigation
6% domestic
0% industrial



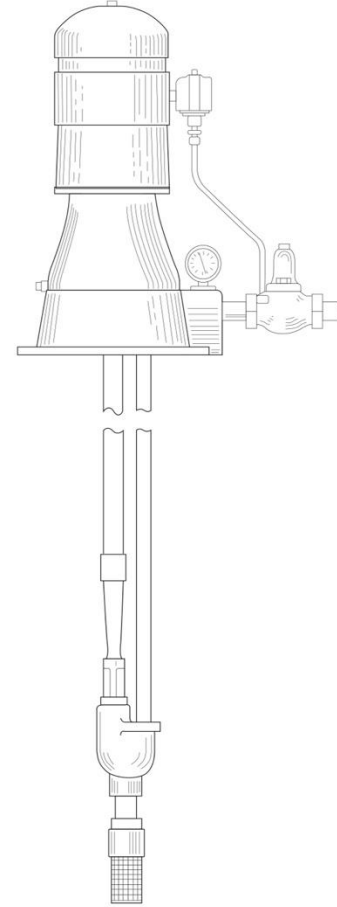
Anatomy of pumps, wells, and groundwater earth



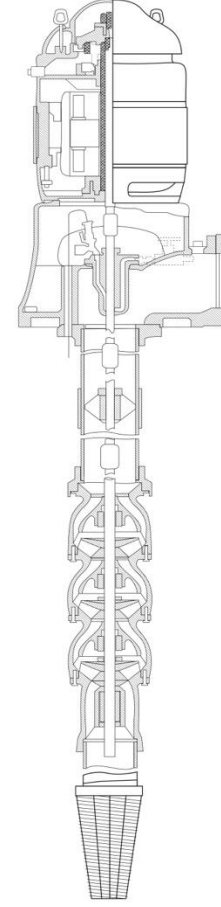
Hand pump



Plunger pump

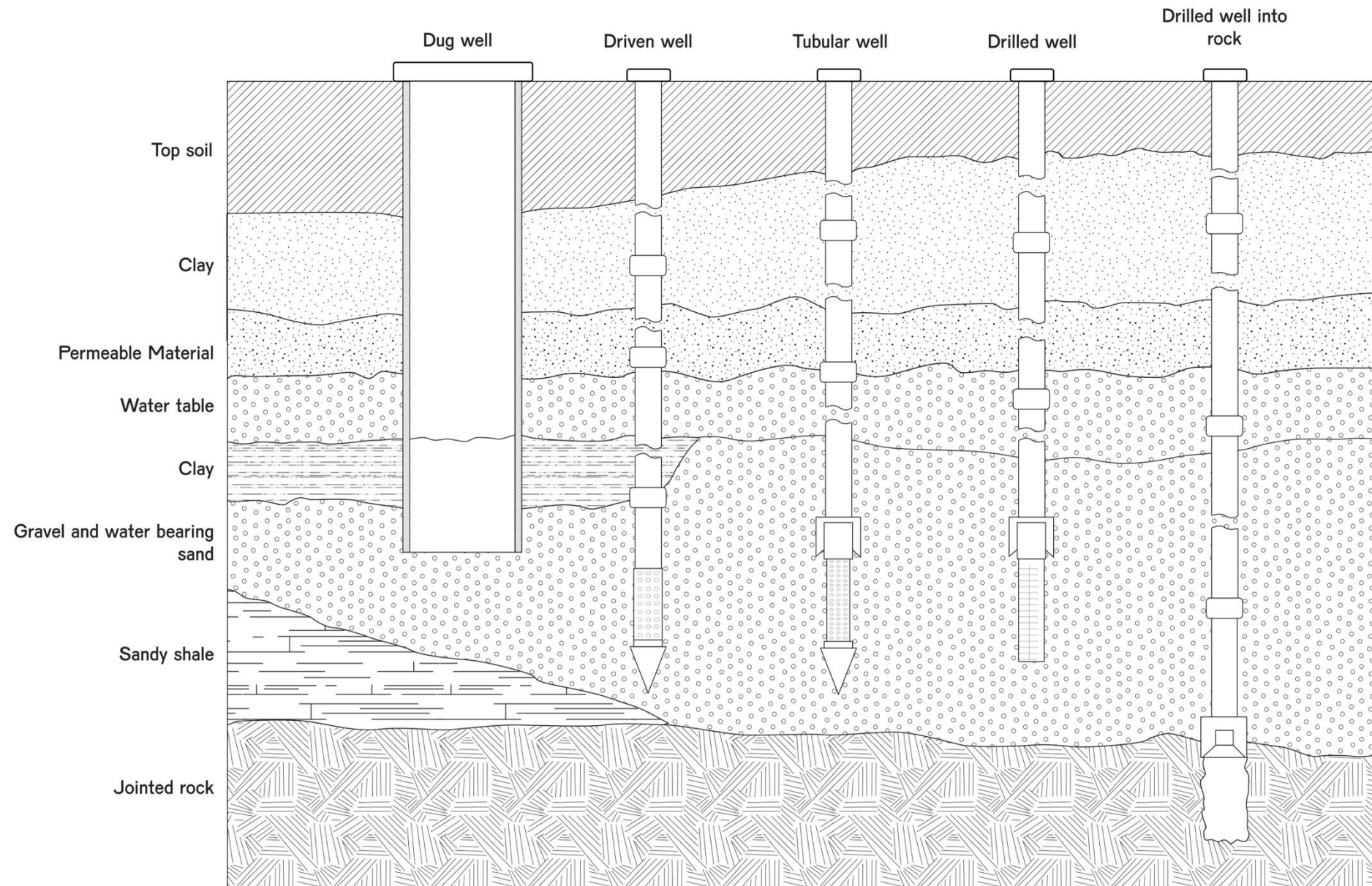


Jet pump



Vertical turbine pump

Most commonly installed pumping technologies



Most common well types







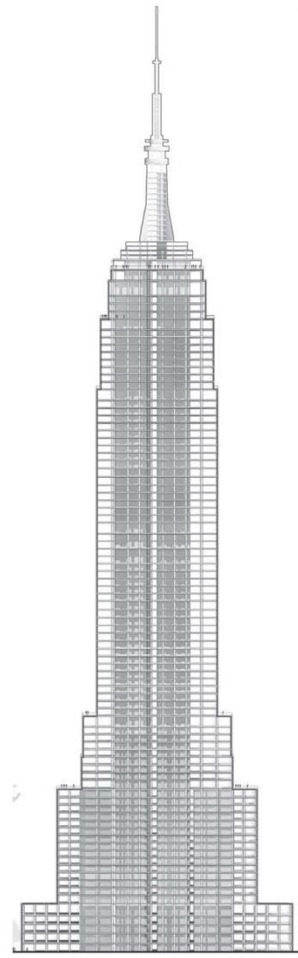
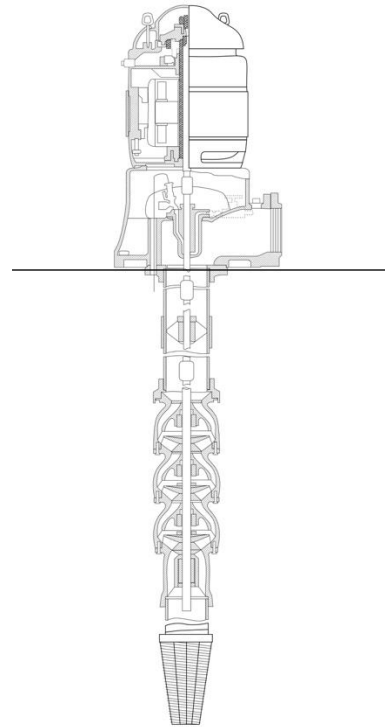
Anthony Acciavatti, Electric-Powered Tubewell in Nilokheri (2024).



Anthony Acciavatti, Electric Powered Tubewell in Shalimar Bagh, Lahore (2024).



Left: Anthony Acciavatti, Wheat fields outside Tucson, Arizona irrigated with water drawn from aquifers (2022).
Right: Anthony Acciavatti, A series of new residential towers dependent on private tubewells in Noida, Uttar Pradesh (2023).

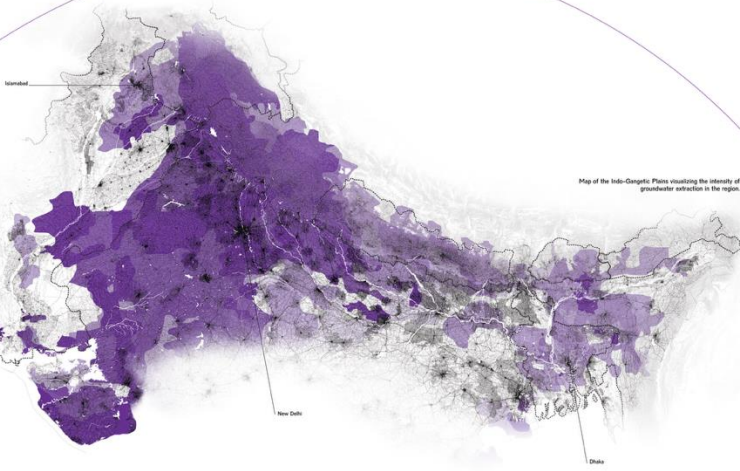


Indo-Gangetic Plains

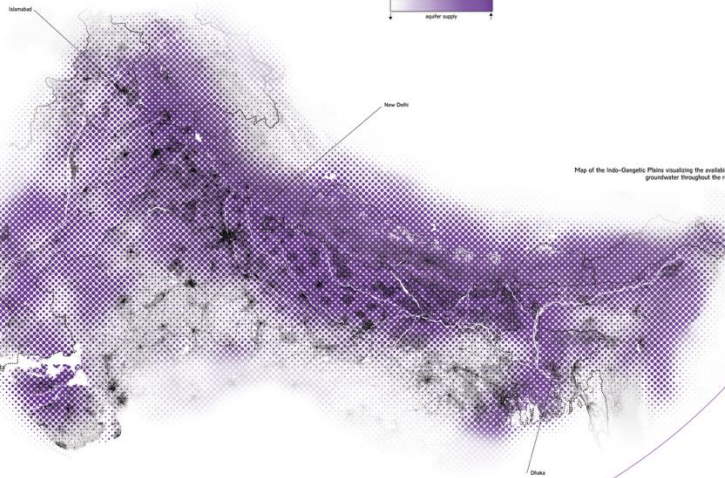
Today the Indo-Gangetic plains are the most densely populated and agriculturally productive area on the planet. Located to the south of the Himalayas, the area spans across portions of Pakistan, India, Nepal, and Bangladesh. Due to the rich alluvium spread across the Ganges and Indus River basins, along with glacial melt and the monsoons, for centuries the region has been a testing ground for developing a new culture around water management. Composed of highly centralized systems, like the Ganges Canal, along with millions of decentralized technologies, like tubewells for drawing up groundwater from aquifers, the area is a layered super-surface of hydrological systems.

Region

Map of the Indo-Gangetic Plains visualizing the intensity of groundwater extraction in the region.



Map of the Indo-Gangetic Plains visualizing the availability of groundwater throughout the region.

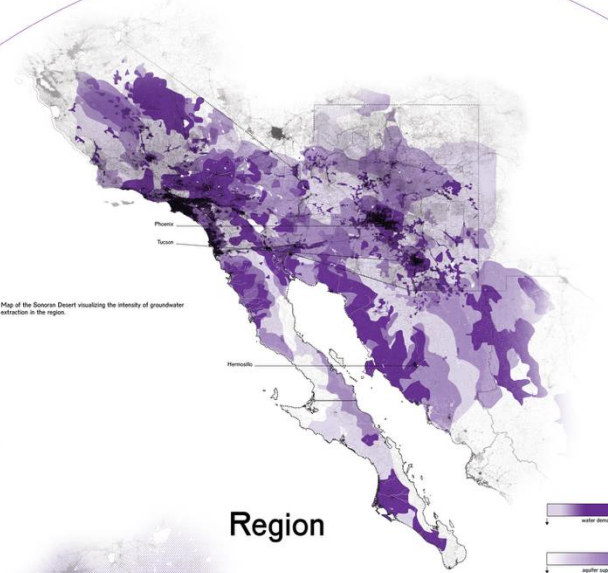


Sonoran Desert

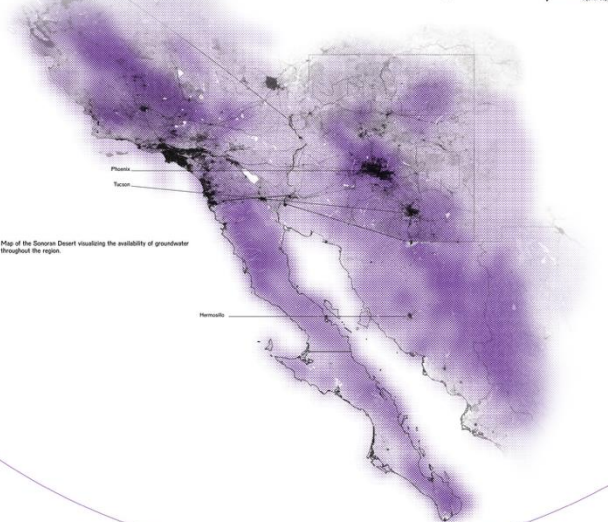
Rich in fauna and flora, alongside patches of cities and farms, the biomes of the Sonoran Desert burst with biodiversity. Undergirding these diverse ecosystems are aquifers that took thousands of years to form. The aquifers, like the desert itself, stretch across the U.S. and Mexico as well as nearly 20 indigenous communities and cultures. As diverse as they each are in their histories, political structures, property rights, and envisions, today they all exhibit a thirst for groundwater. Political and material conflicts arise over the competing demands to irrigate water-intensive crops and supply potable water to millions of people.

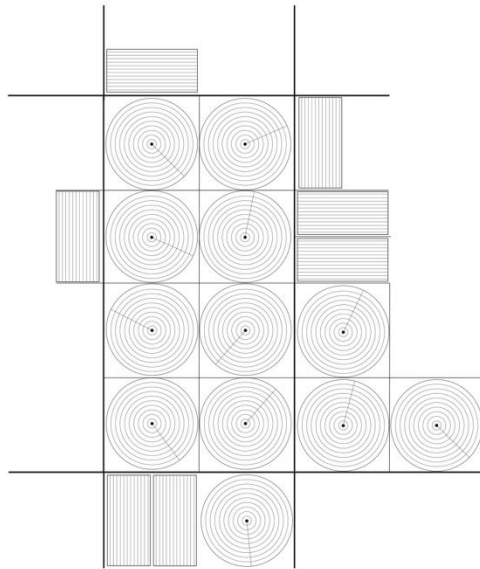
Region

Map of the Sonoran Desert visualizing the intensity of groundwater extraction in the region.

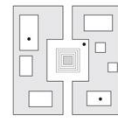


Map of the Sonoran Desert visualizing the availability of groundwater throughout the region.

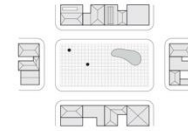




Pivot irrigation wells



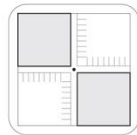
Shared and private wells



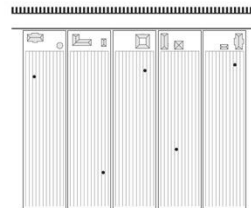
Park with shared wells



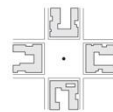
One house, one well subdivision



Towers with well



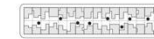
Trunk road with agricultural wells



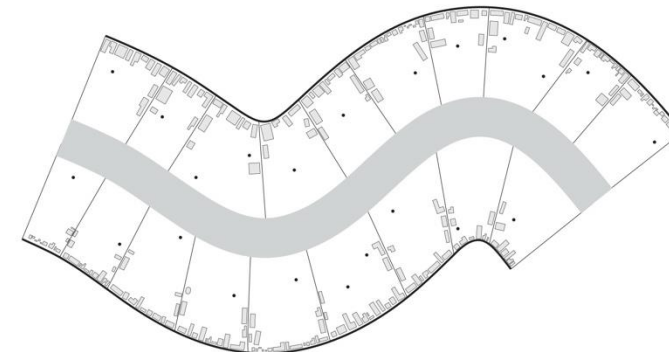
Town square well



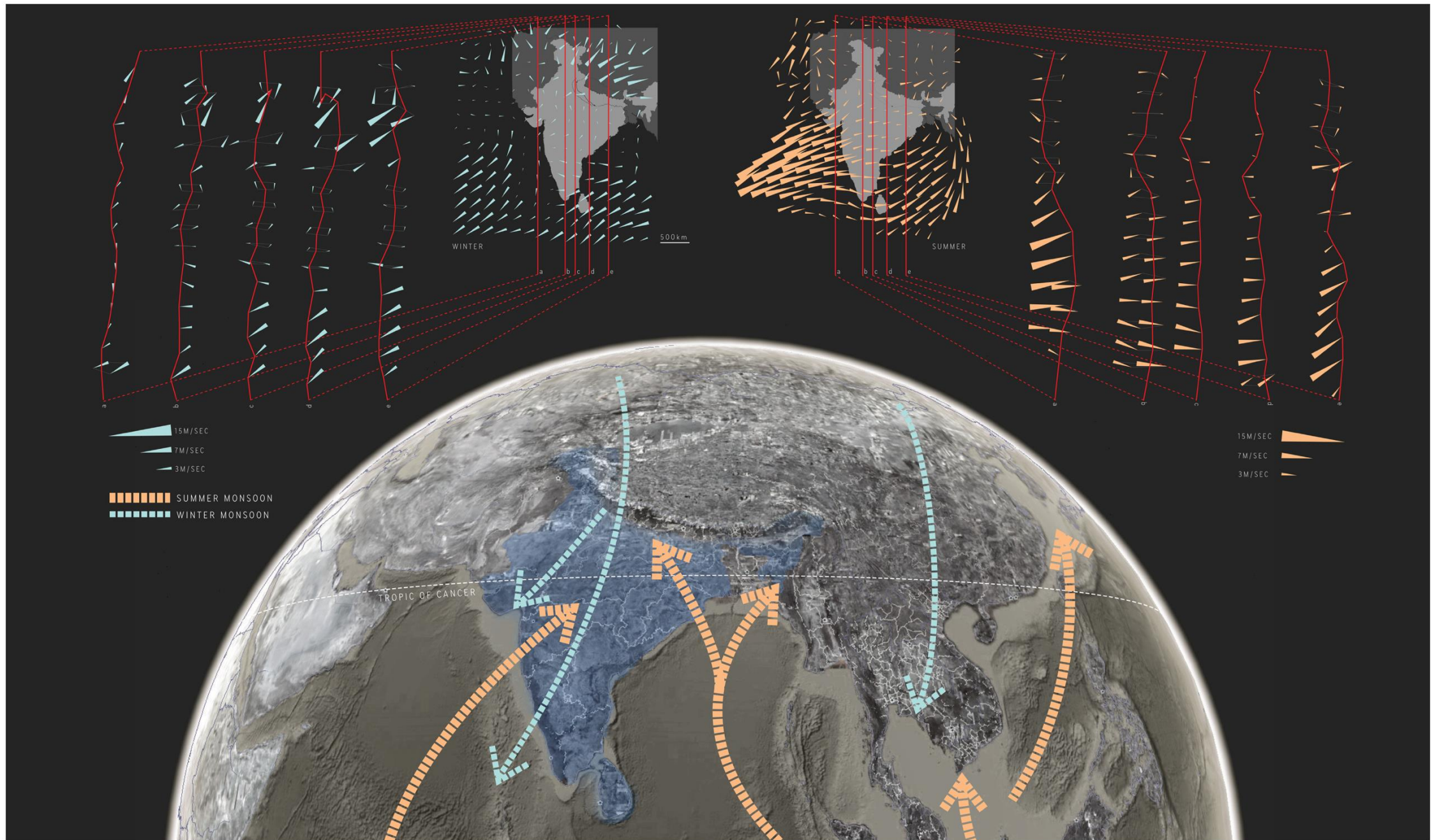
Inner block with shared well

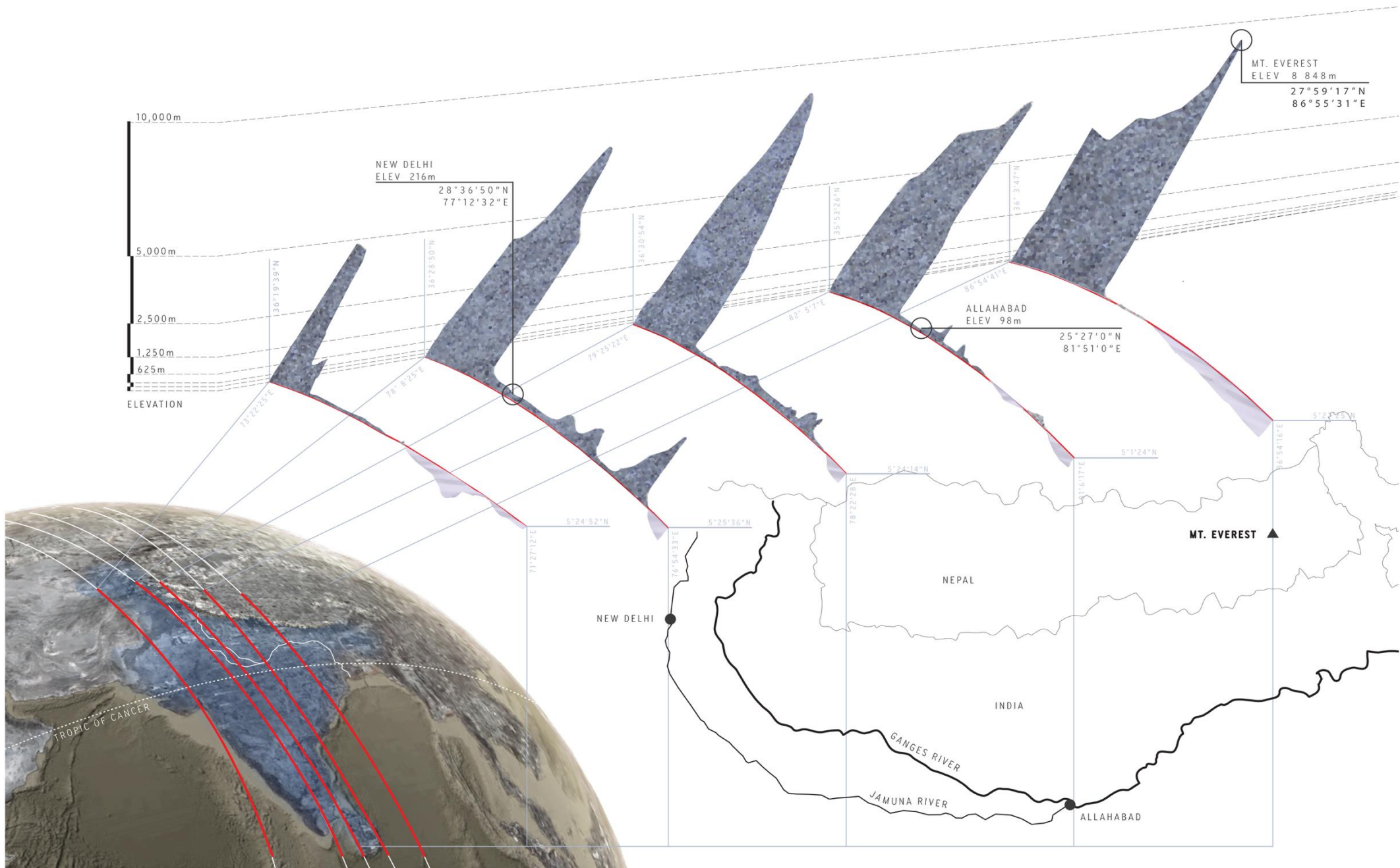


Inner block with private wells

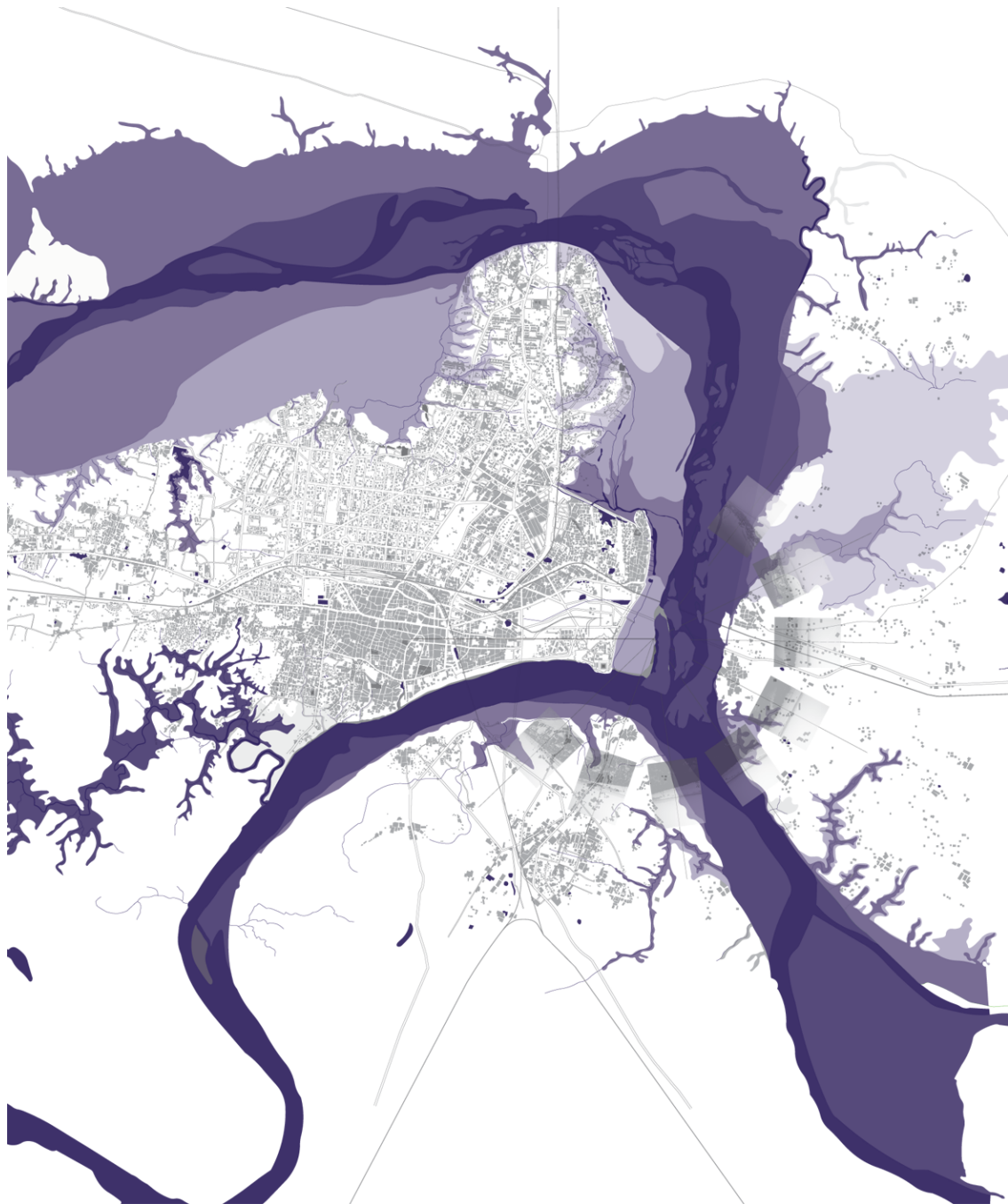


Riparian edge with agrarian wells











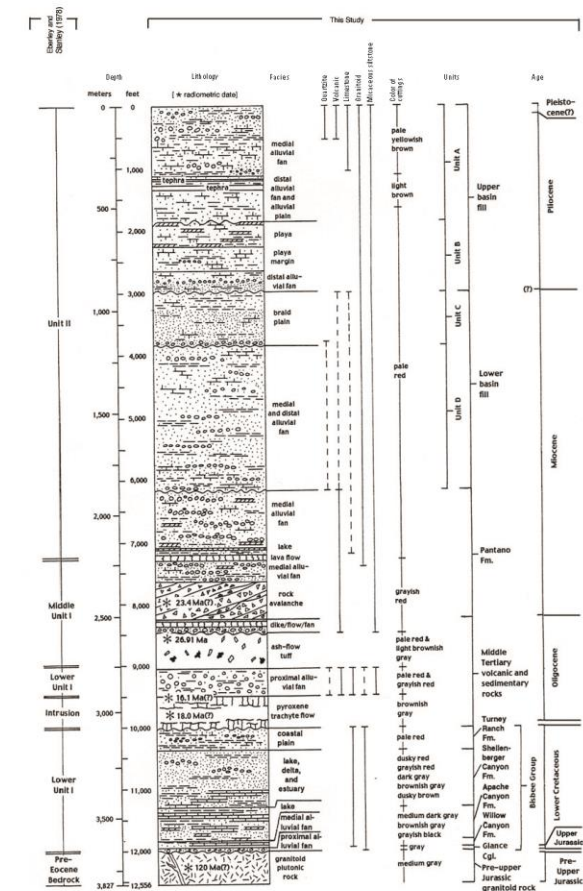
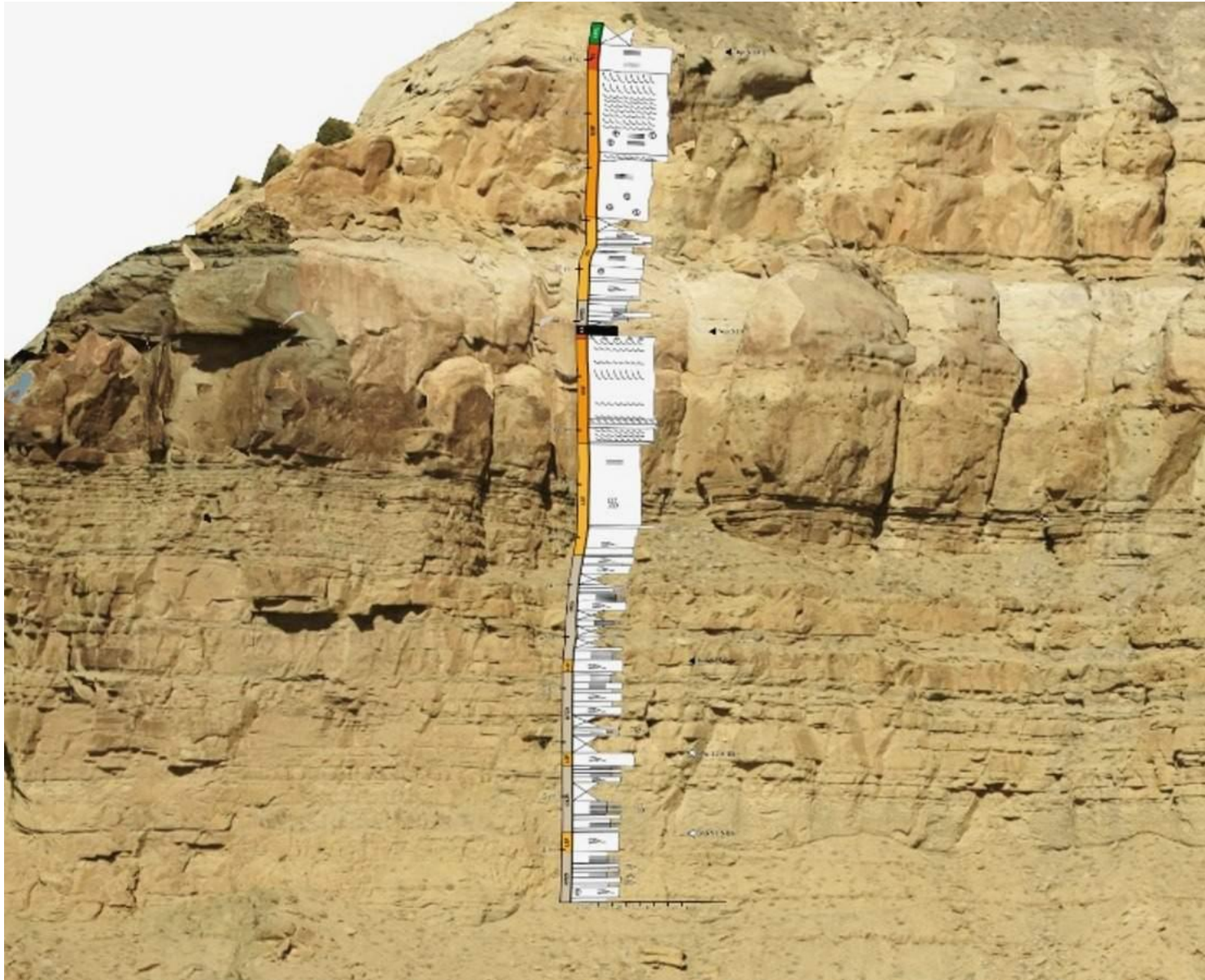
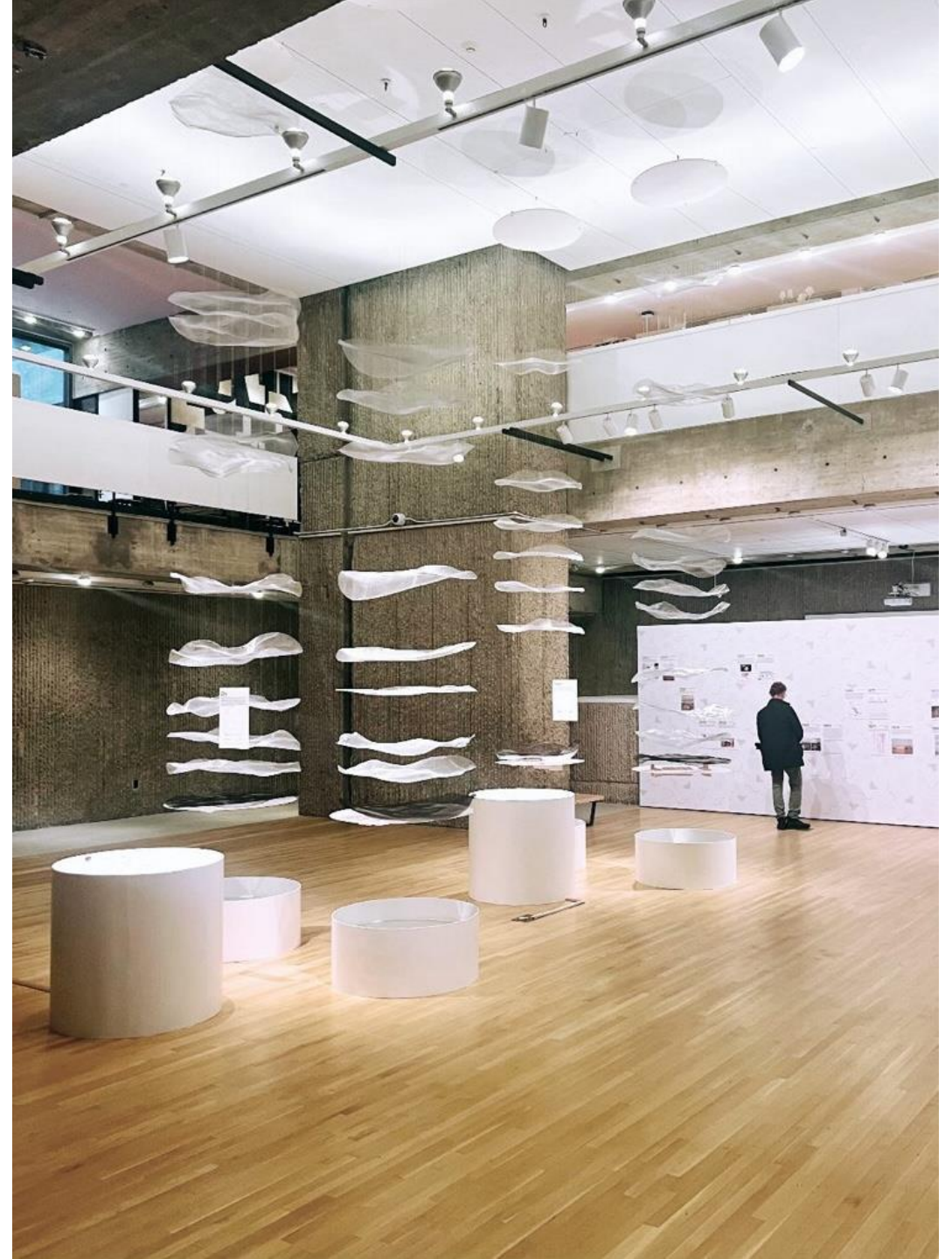
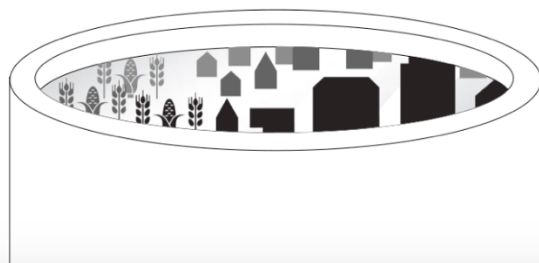
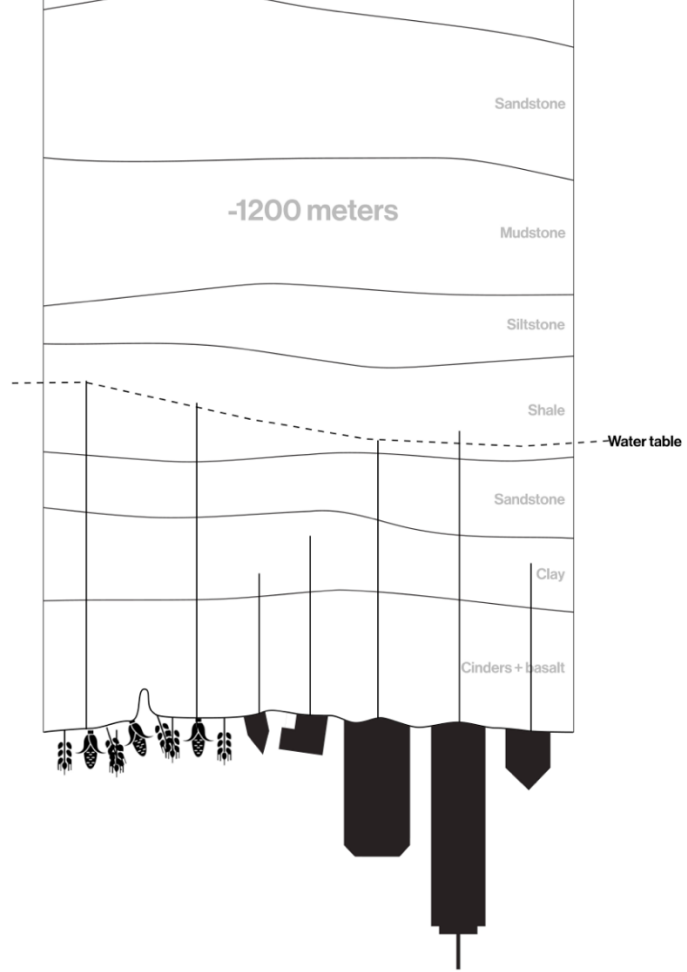
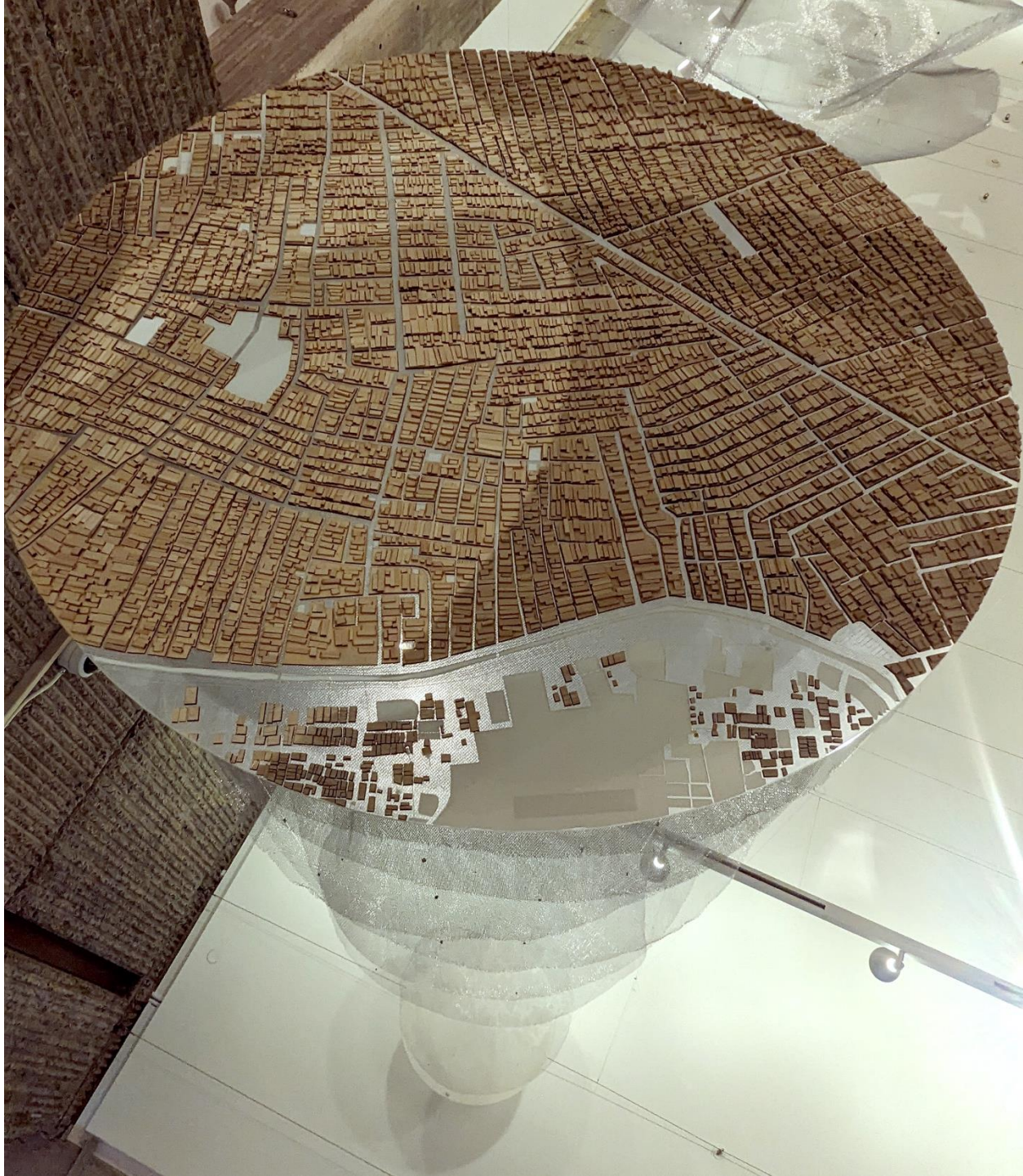


Figure 4. Stratigraphic column for the Exxon State (32)-1 well. Dashed lines under clast-lithology heading indicate intervals where the lithology is rare. Queried radiometric dates are from Eberley and Stanley (1978); the 26.91 Ma age date on the ash-flow tuff was obtained in this study. The stratigraphic correlation of Eberley and Stanley (1978) for southwestern Arizona is shown at the left. In the Exxon well, they correlated Unit II with basin fill, middle Unit I with middle Tertiary volcanic and sedimentary rocks, and lower Unit I with the Pantano Formation.

Left: Sedimentary log placed relative to outcrop model (courtesy of Dr Christian Haug Eide, University of Bergen).

Right: Brenda B. Houser, Lisa Peters, Richard P. Esser, and Mark E. Gettings, *Stratigraphy and Tectonic History of the Tucson Basin, Pima County, Arizona, Based on the Exxon State (32)-1 Well* (2004)





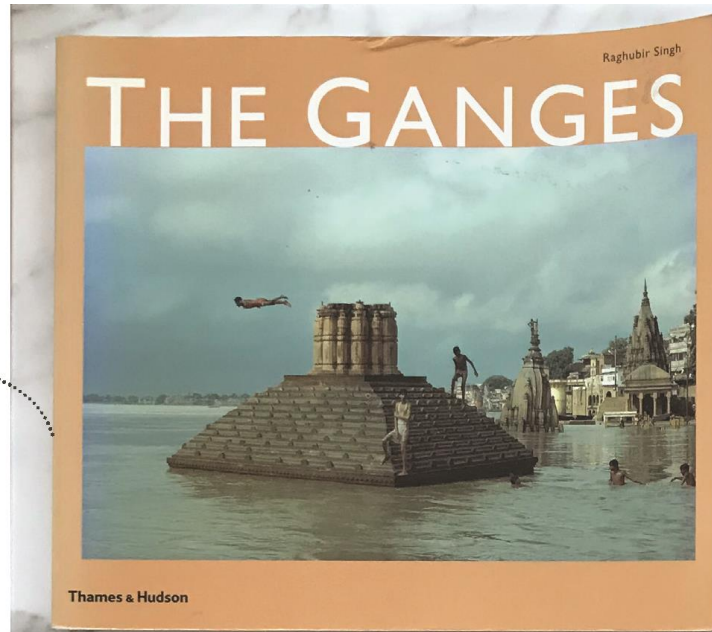
ساستا استر از غرت یافت و در غنوان پرده اراشی شب سید عبدالمعدن خان در باره روبراه در آنچو د به غیر فرستاد و لیا
 اقبال و فروشدن با سپاسانخت کزین کوشایش ملک بکا لیشا علی بنیت افروخت و بهجت عبرت جهانیان سر داد و را



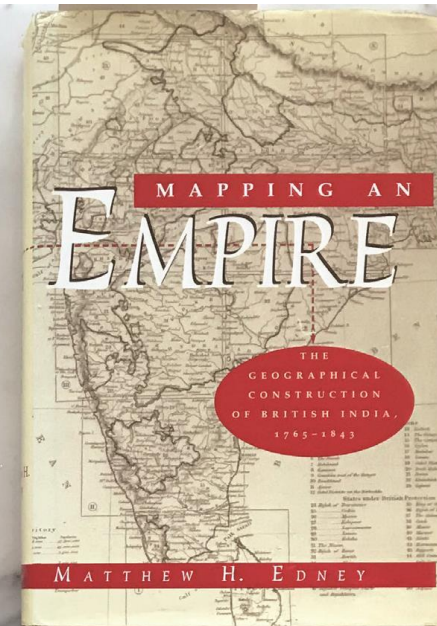
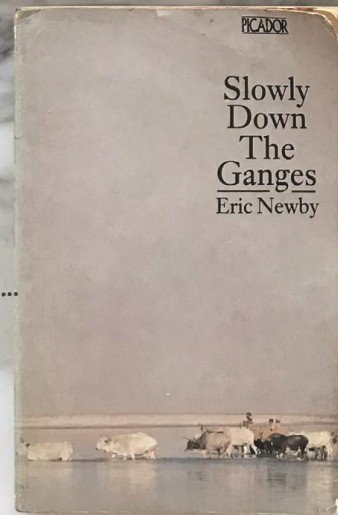
در جلونامه بارگاه والاداخت غریو از نظار کین آثار اقبال برآمد و حالیه تراش طکونما کون در گرفت اگر چه
 عین عنایت خاسته ازاد

2004

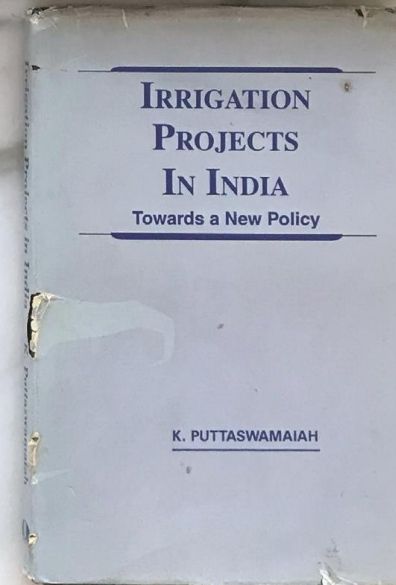
Photo essays



Madcap
Adventures



History of Cartography



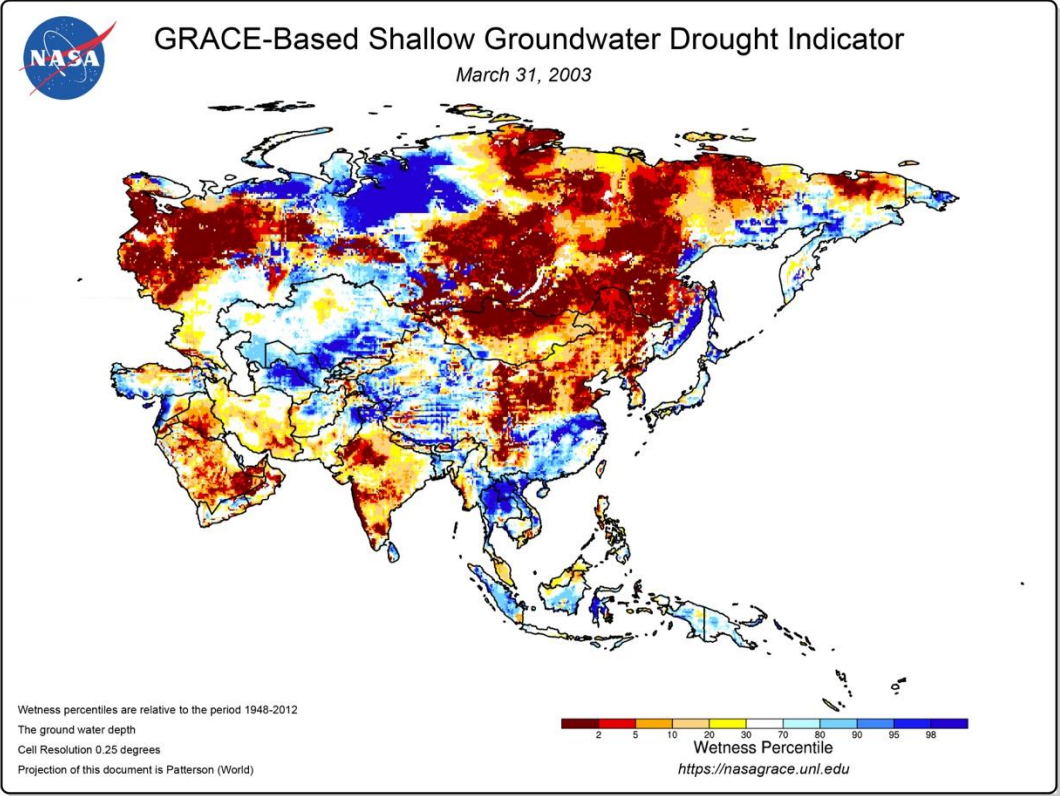
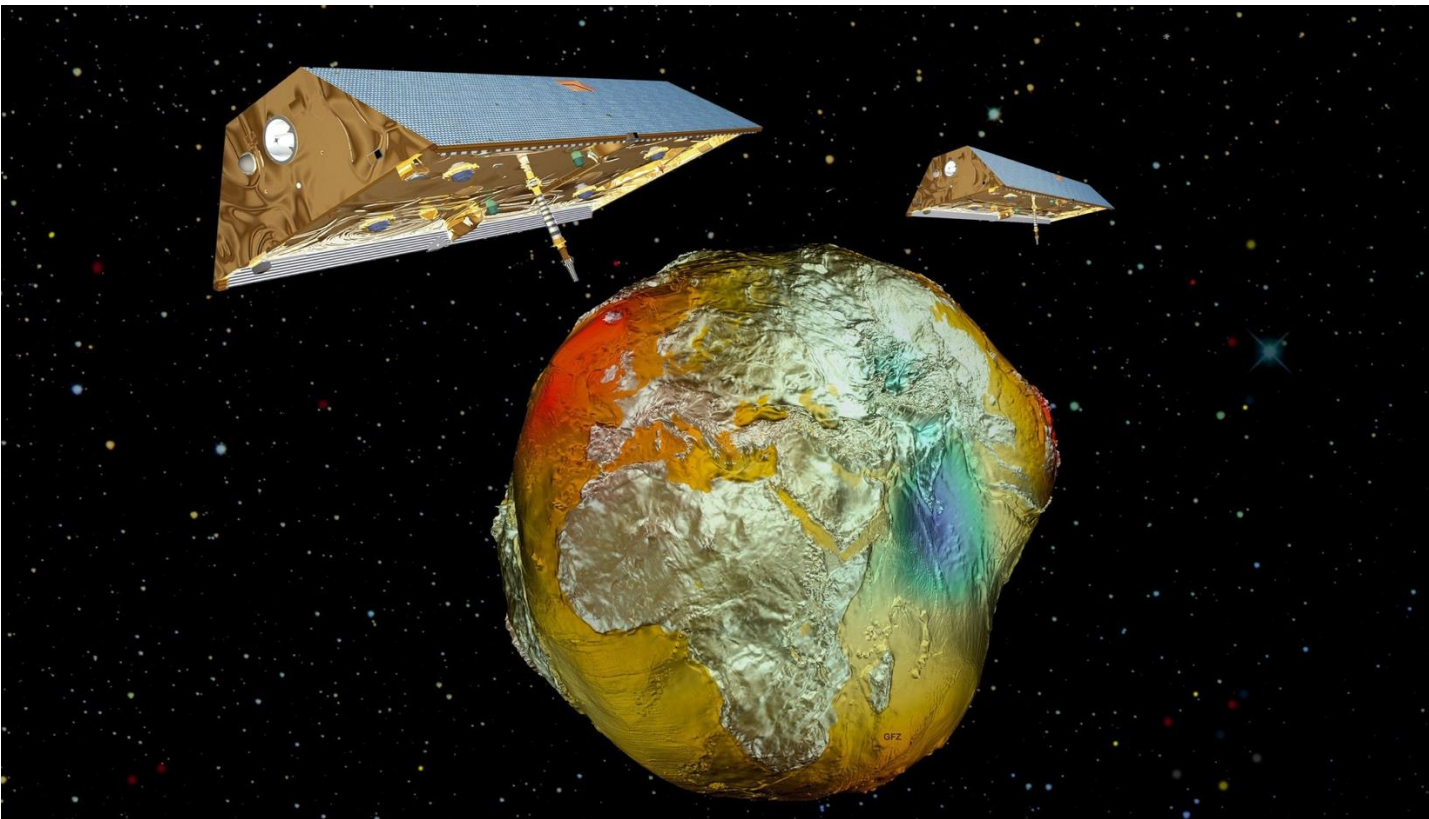
Avalanche of
Statistics

Google™ earth





DJI Phantom



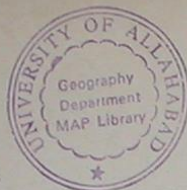
GRACE (Gravity Recovery and Climate Experiment) Twin Satellites with the earth's gravity field vertically enhanced. Launched in 2002 (decommissioned in 2017)



Left: Garmin eTrex Handheld GPS Navigation System 12 Channel (2004)

Right: Nikon CoolPix 5700 (2001)

MAP LIBRARY
Geography Department
Allahabad University
Accession No. 199
Date
Classification No. 0-104



KĀNPUR & UNNĀO DISTRICTS.

Surveyed 1974-75.

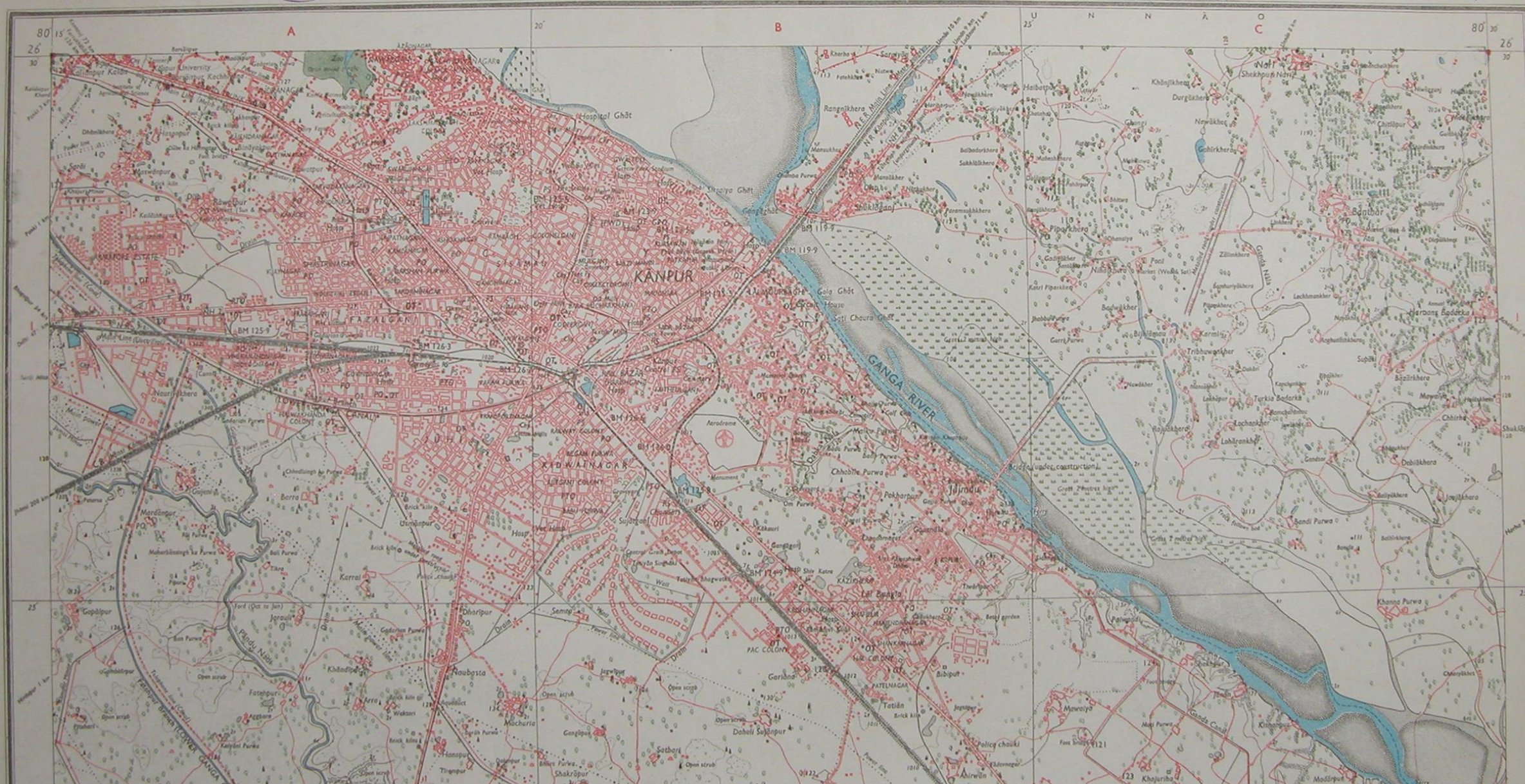
UTTAR PRADESH

FIRST EDITION

Magnetic Variation from True North about $\frac{1}{2}^{\circ}$ West in 1970.
(Decreasing by about $\frac{1}{4}^{\circ}$ annually.)

INDIA
REFER TO THIS MAP AS - 1:50,000
SHEET 63 B/7 FIRST EDITION

No. 63 B/7





Anthony Acciavatti (c. 2006)



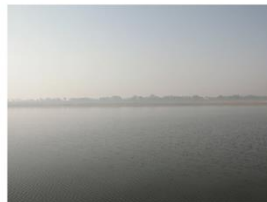
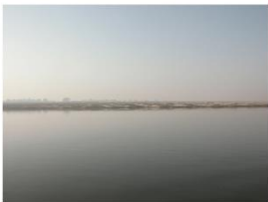
Anthony Acciavatti (c. 2006)

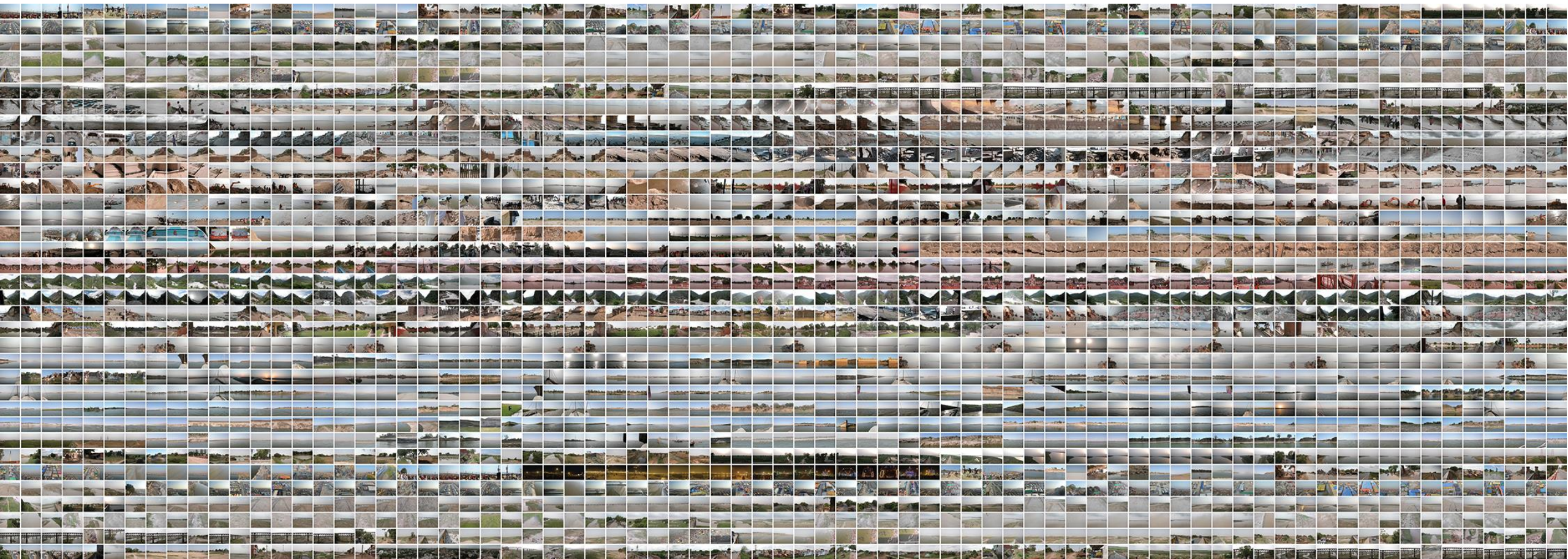


Anthony Acciavatti (c. 2006)

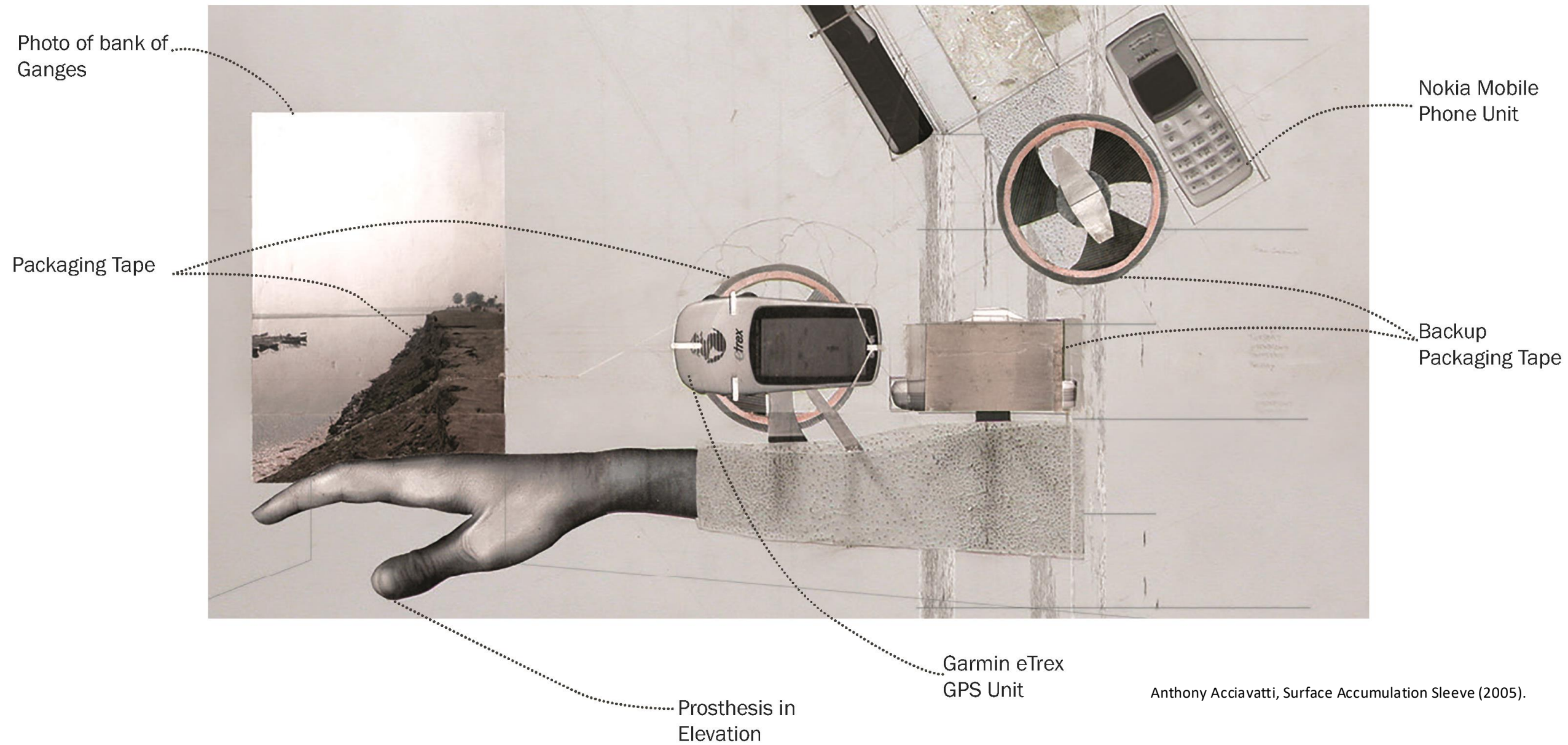


Aciavatti, Gangotri Glacier (2006)





Anthony Acciavatti, "Panorama of Ganga River Basin," 2005-2014.
Permanent Collection, Victoria and Albert Museum in London. Accession Number CD.22-2023





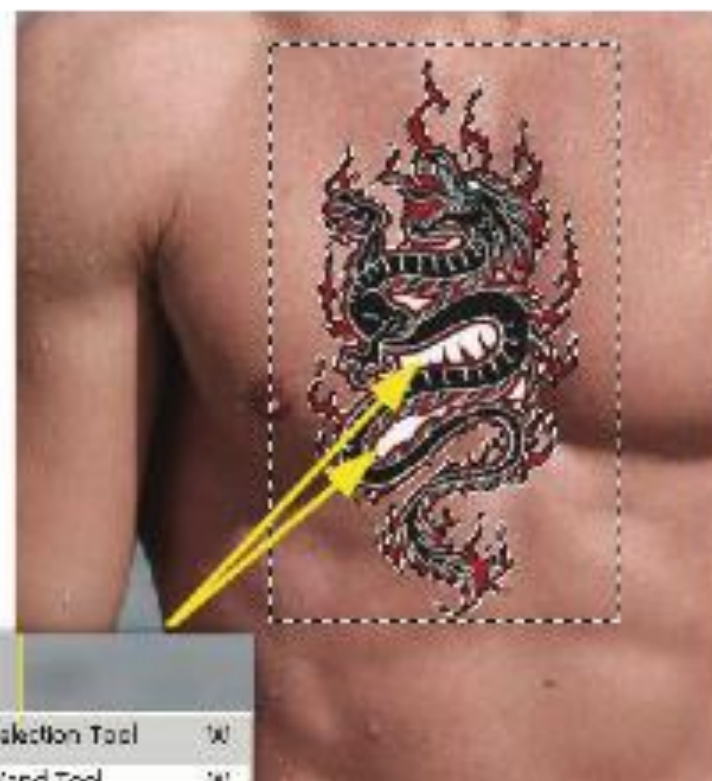
..... 1km long Tape
Imprint in Silt

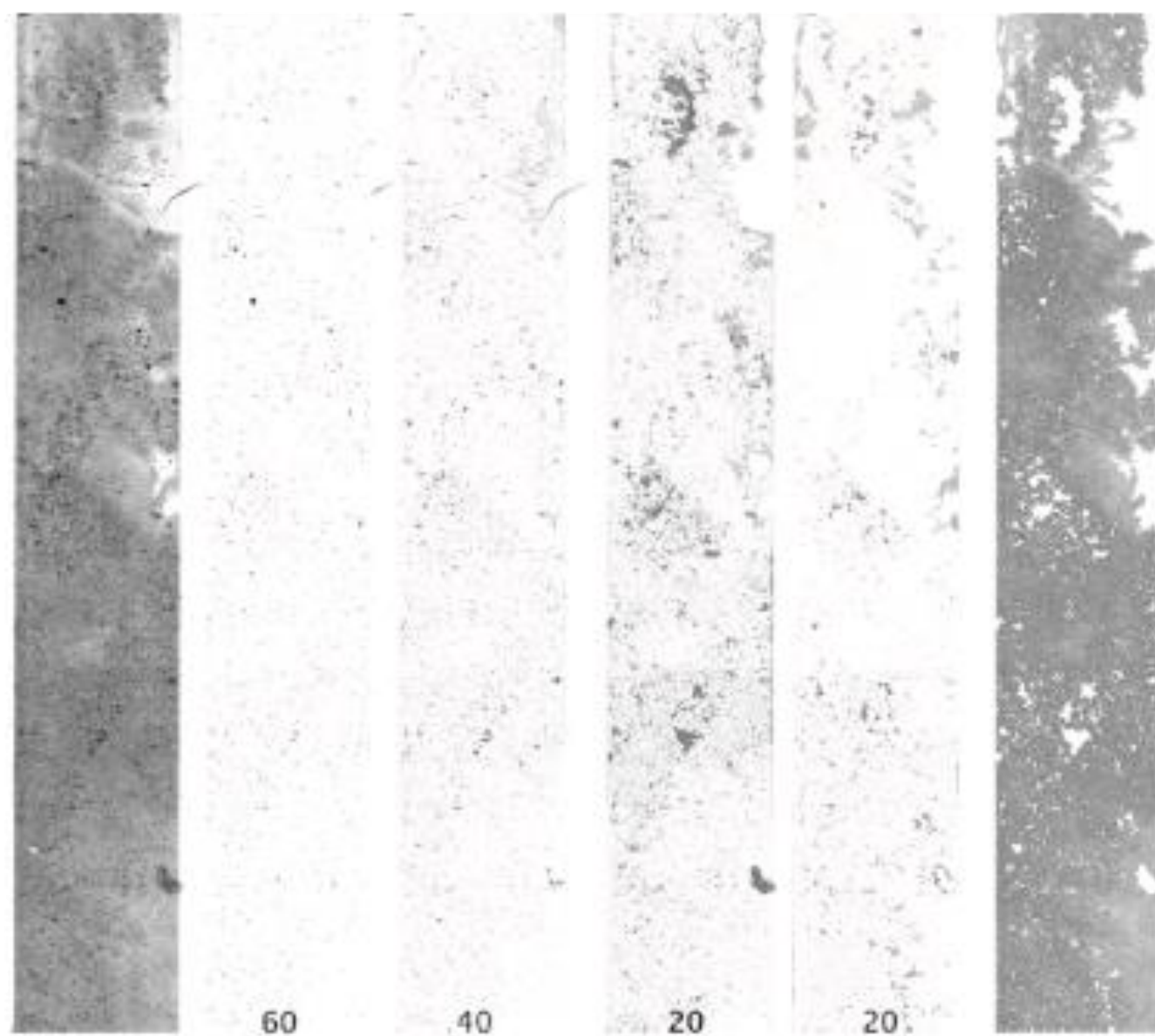


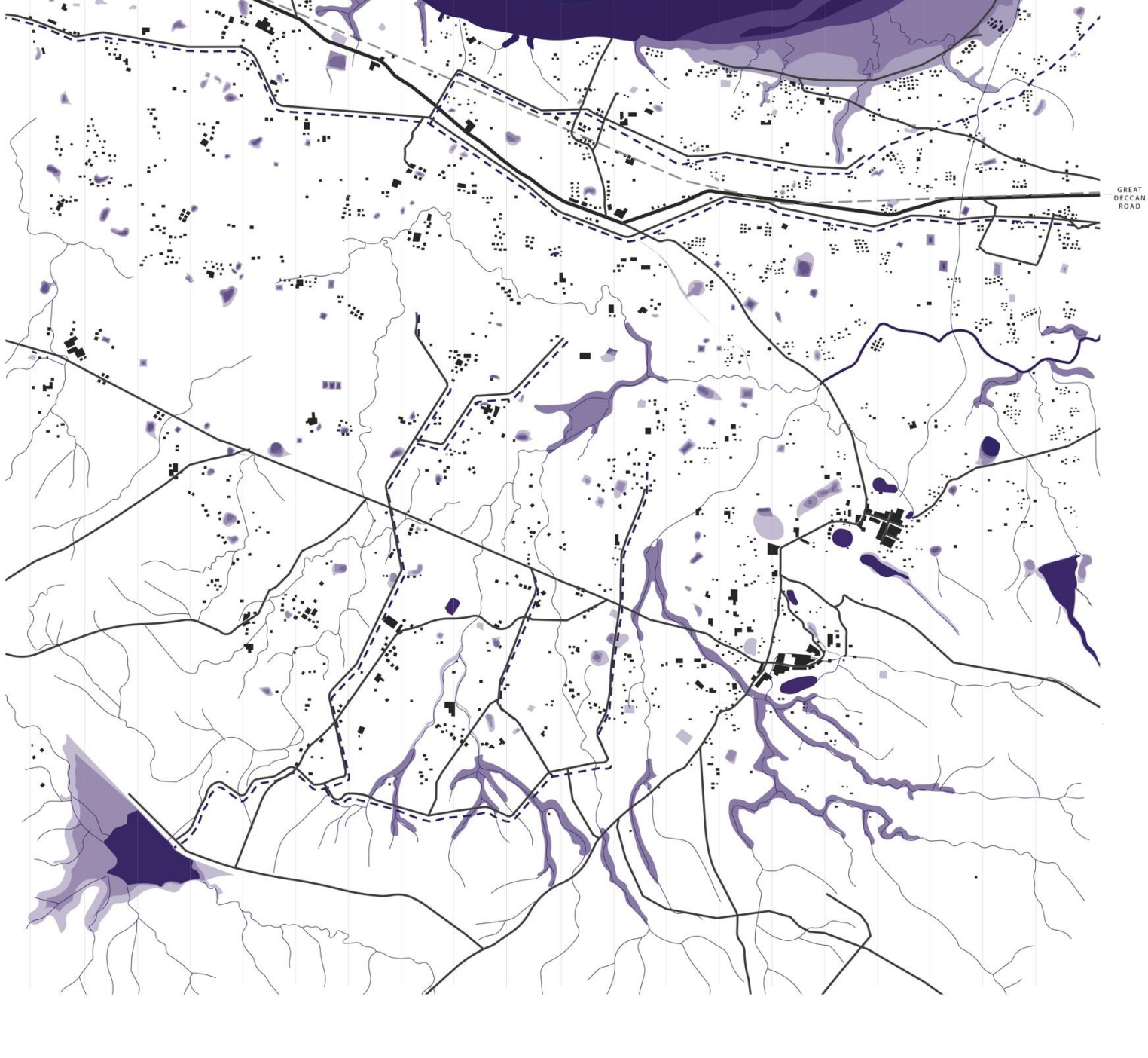
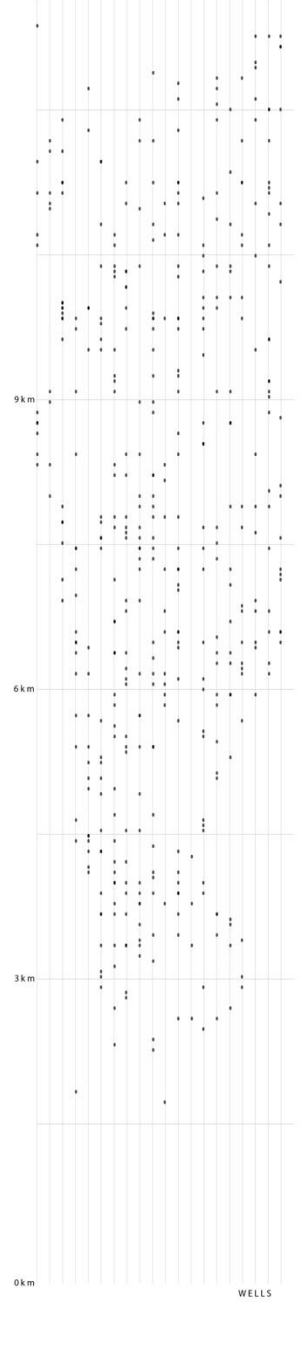
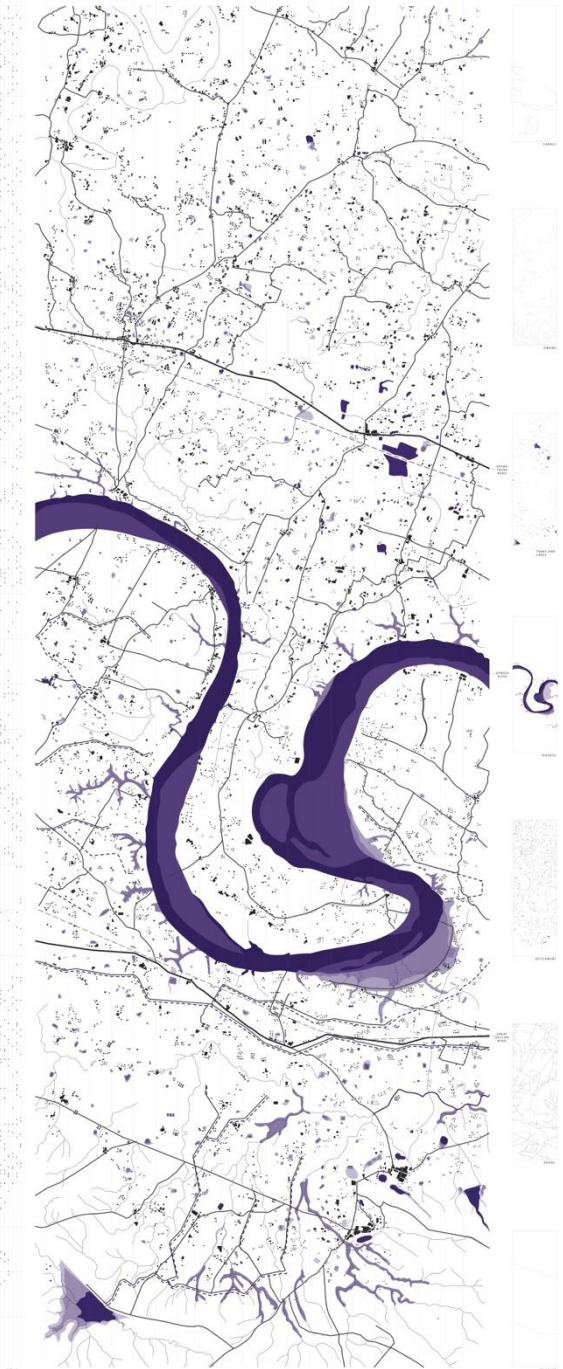
Surface Accumulation Sleeve II (2009, 2019). Photo ©Hatnim Lee
Permanent Collection, Victoria and Albert Museum in London. Accession Number CD.16:1 to 4-2023





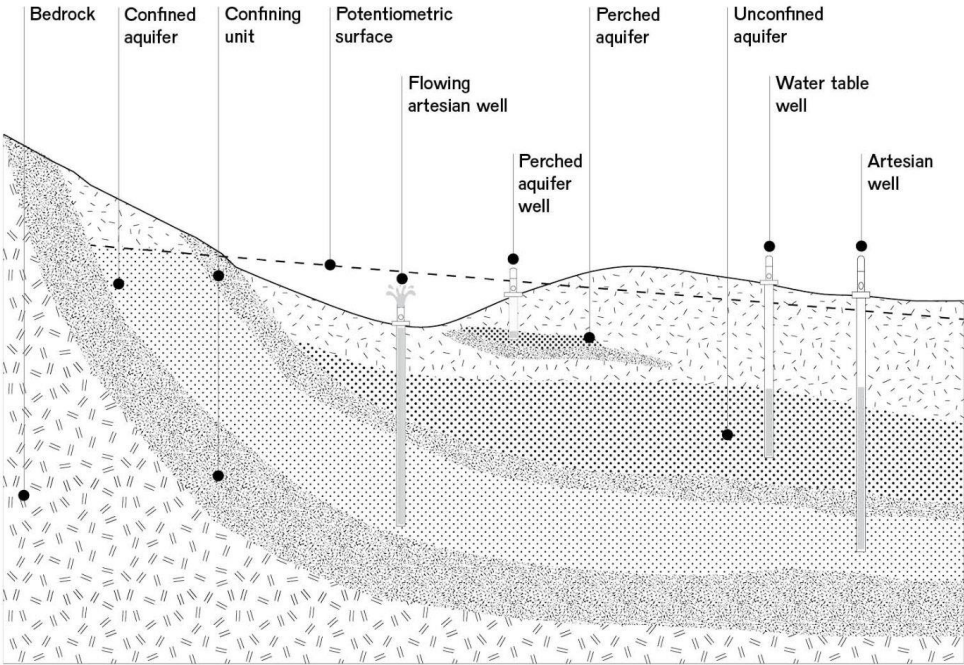
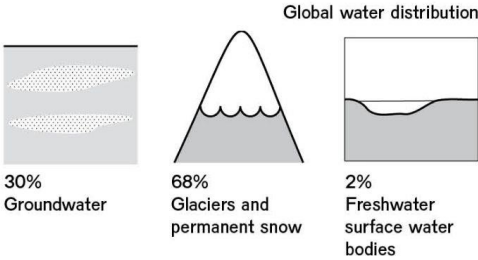






Aquifers

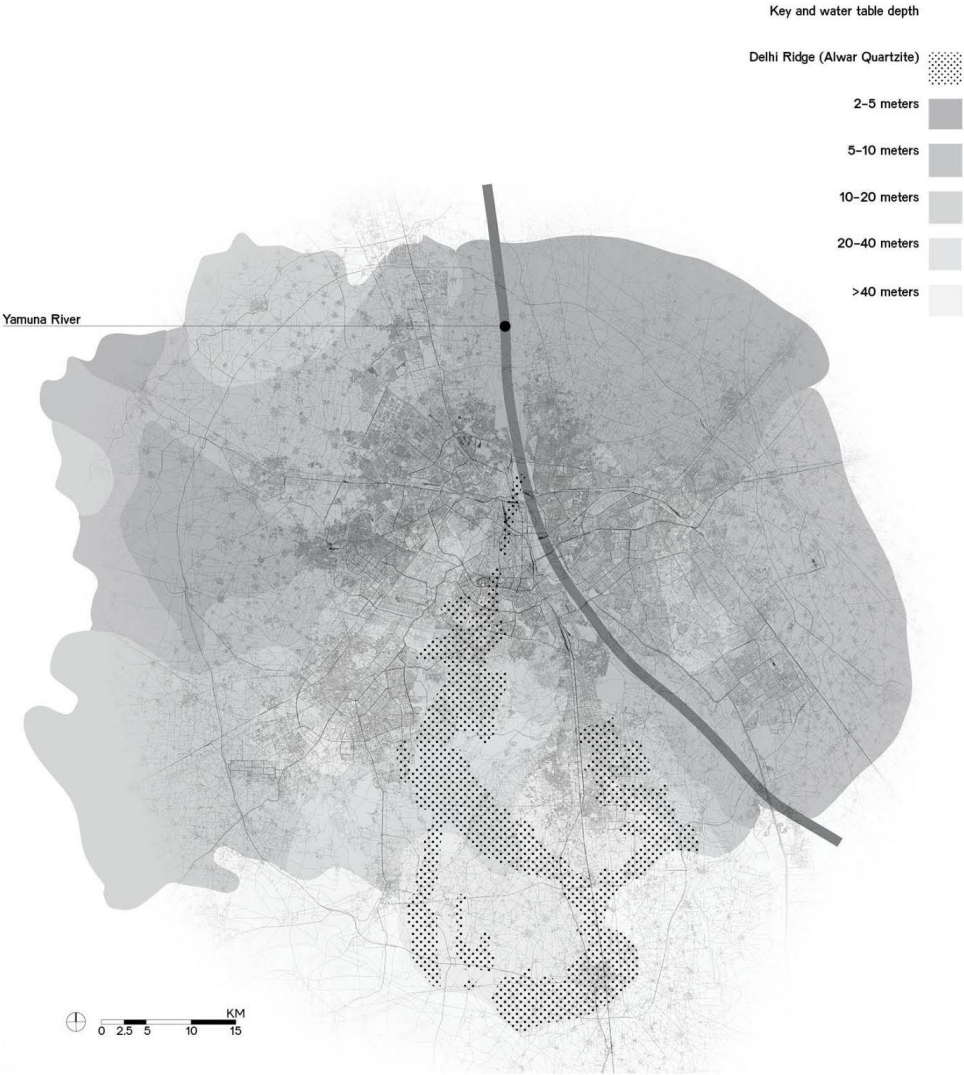
Glossary



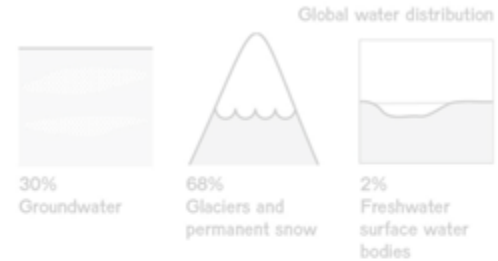
Sectional drawing showing the most common types of aquifers.

New Delhi

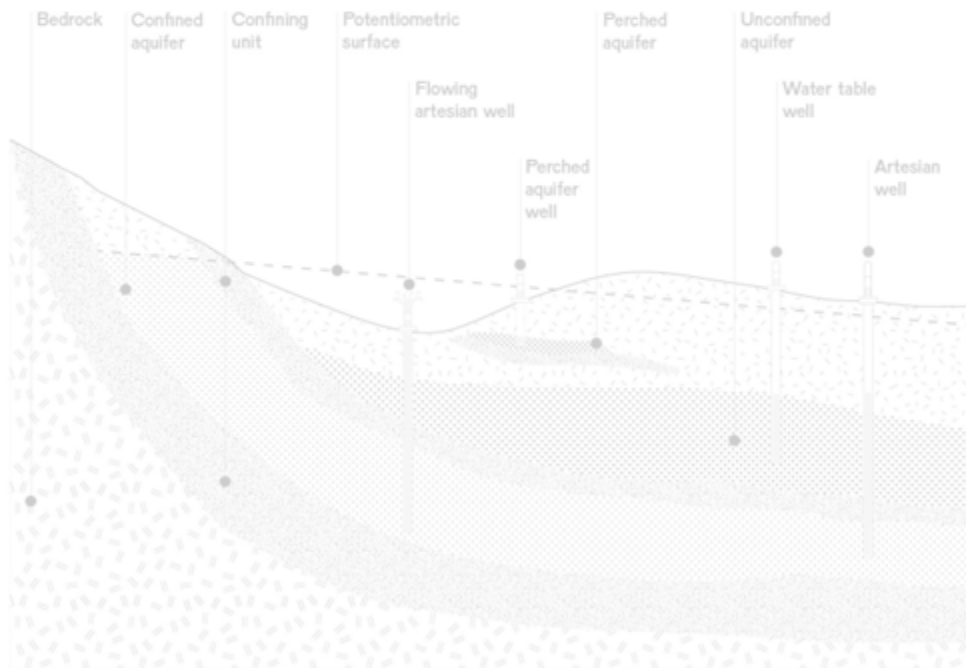
Glossary



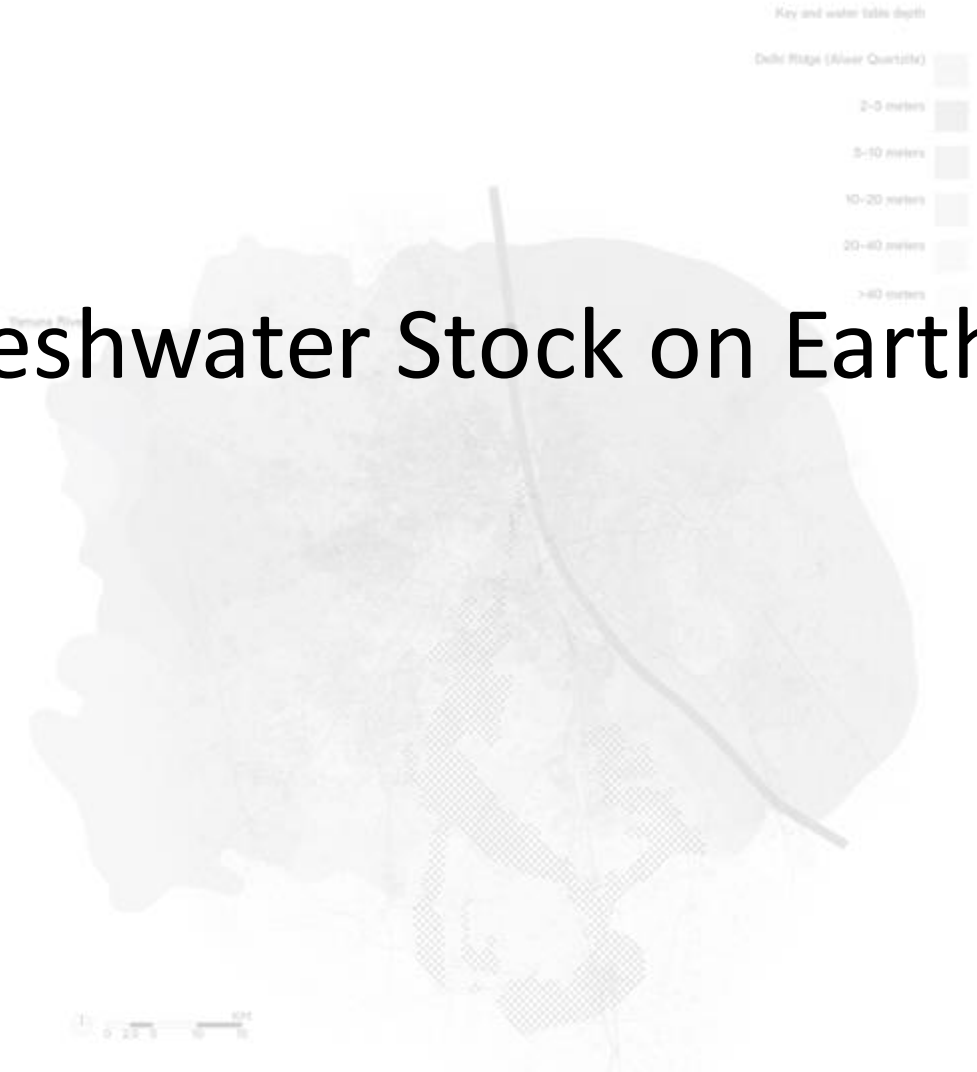
Plan of the New Delhi metropolitan region visualizing the varying depths of the water table.
Source: Central Ground Water Board, Government of India.



Groundwater: 99% of Liquid Freshwater Stock on Earth



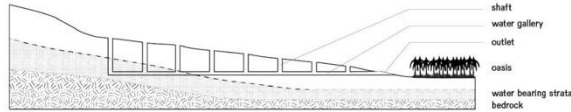
Sectional drawing showing the most common types of aquifers.



Plan of the New Delhi metropolitan region visualizing the varying depths of the water table.
Source: Central Ground Water Board, Government of India.

1000_{BCE} Public Works

A device for delivering water from an aquifer to the surface for irrigation, a qanat, also known as a falaj or karez, are horizontal tunnels built throughout North Africa, Middle East, Eurasia, and South Asia. A mother well at the source end allows water to enter the tunnel, which has a slight slope to ensure gravity flow. Well shafts penetrate the horizontal tunnel for ventilation, access, and maintenance. Qanats have been used to sustain cities and agricultural areas alike.



Section showing the underground aqueduct mechanism for extracting water (top). Aerial view of the oases of Al Ain (United Arab Emirates) irrigated through a Falaj network in 1960 (bottom). Image courtesy of Abu Dhabi Authority for Culture and Heritage.

200_{BCE} Lift Irrigation

The *saqiya*, also known as a Persian Wheel, most likely came to the subcontinent in the 1300s. A technology for lifting up water from a well dating back to 200 BCE, a set of buckets are attached to a wheel or rope to a wheel that is powered by bullocks. As the bullocks turn the wheel to draw up the water buckets, each bucket empties onto a channel for irrigation.



A Persian wheel, used in raising water from the ground. Illustration by David Roberts (published between 1846 and 1849). Image courtesy of Library of Congress.

100_{BCE} Lift Irrigation

A longstanding technique for lifting water from a well across much of South Asia, the mot is typically a leather bag that is lowered by rope into a well. Lifting and filling the bag is done with bullocks, who are driven up and down an incline so that they can then deposit water into irrigation channels.

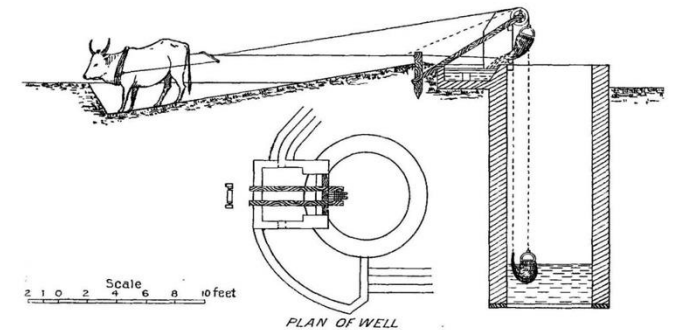
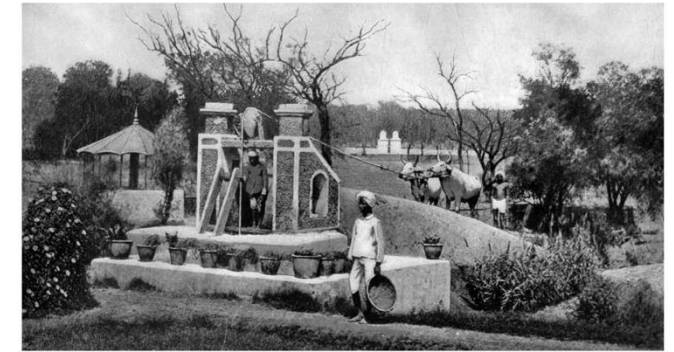


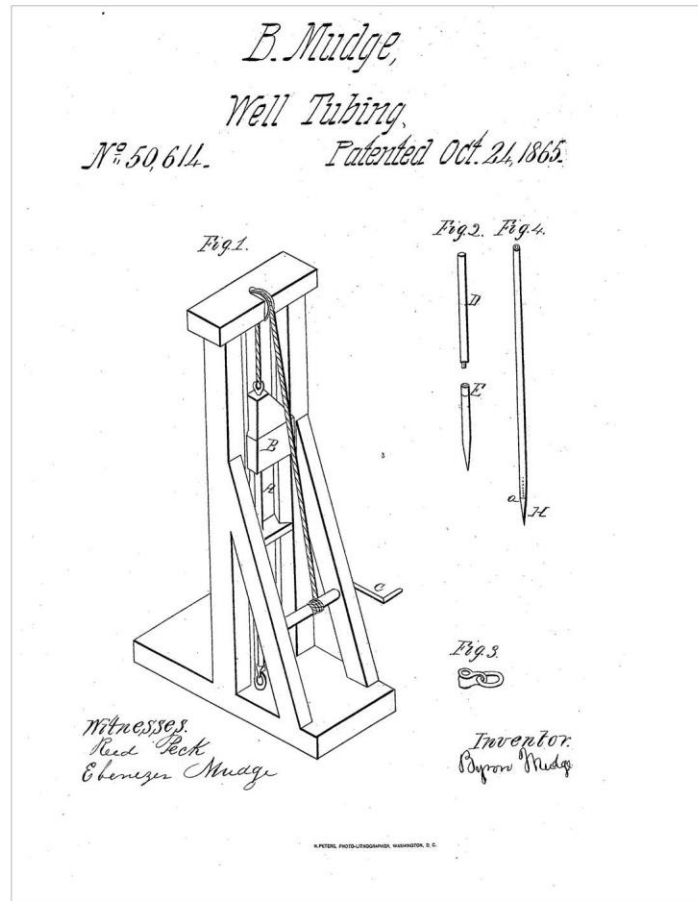
Image of a mot in use by three people, along with a section and plan drawing from Herbert M. Wilson, *Irrigation in India* (Washington, D.C.: Government Printing Office, 1892).



1865

Historic Events

In 1865, Cortlandville, New York, resident Byron Mudge received a patent for an "Improved Method of Sinking Wells." The design involved sinking an iron pipe into the ground and then attaching a pump so that a "supply of water may be readily obtained for family use or for an army on the march or in camp." A soldier in the American Civil War, Mudge was concerned that Confederate troops might poison surface water bodies like lakes and ponds, so he claimed to have deployed his invention in Virginia to draw potable groundwater.

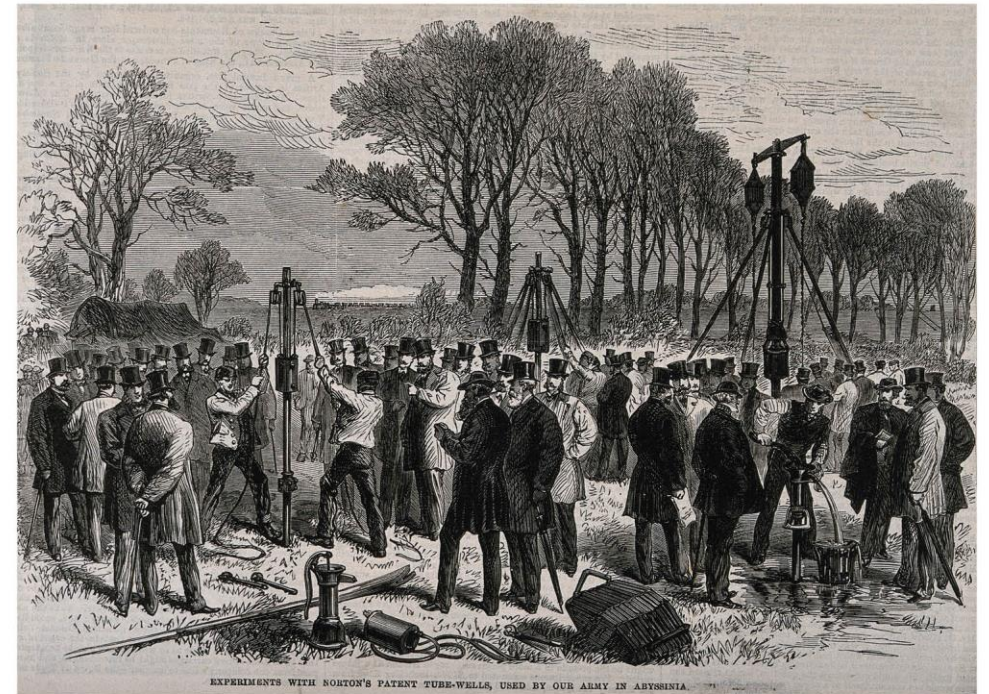


Byron Mudge, Improved Mode of Sinking Wells. U.S. Patent 50,614, issued October 24, 1865.

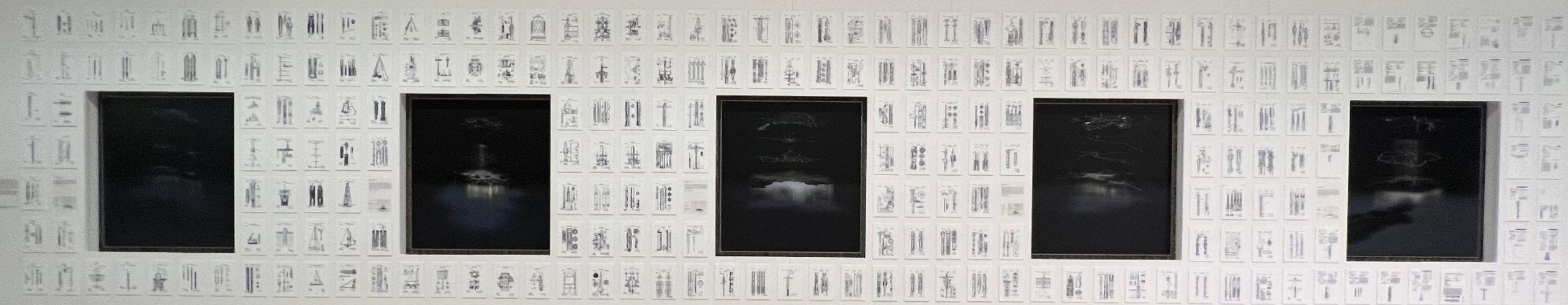
1868

Historic Events

In 1867, James Lee Norton of London patented a version of the tubewell, combining Byron Mudge's process of boring an iron pipe into the ground with his own 1862 patent for "Machinery for Raising and Forcing Water" by means of a pump. With a knack for publicity, Norton managed to have The Illustrated London News report on a public demonstration of his tubewell in Thames Ditton outside London. However, the tubewell really gained recognition in the popular press during the 1868 Abyssinian War. It was in Abyssinia (present-day Ethiopia), that British troops relied on this patented technology to draw up potable water from beneath the desert floor. Medical journals like The Lancet and engineering publications like Scientific American printed stories about the wonders of the tubewell in Abyssinia and its ability to easily draw up pure drinking water.



Etching of experiments with Norton's patent tubewells in Abyssinia. From "Experiments with Norton's patent tube-wells," *The Illustrated London News* (March 21, 1868), 272.



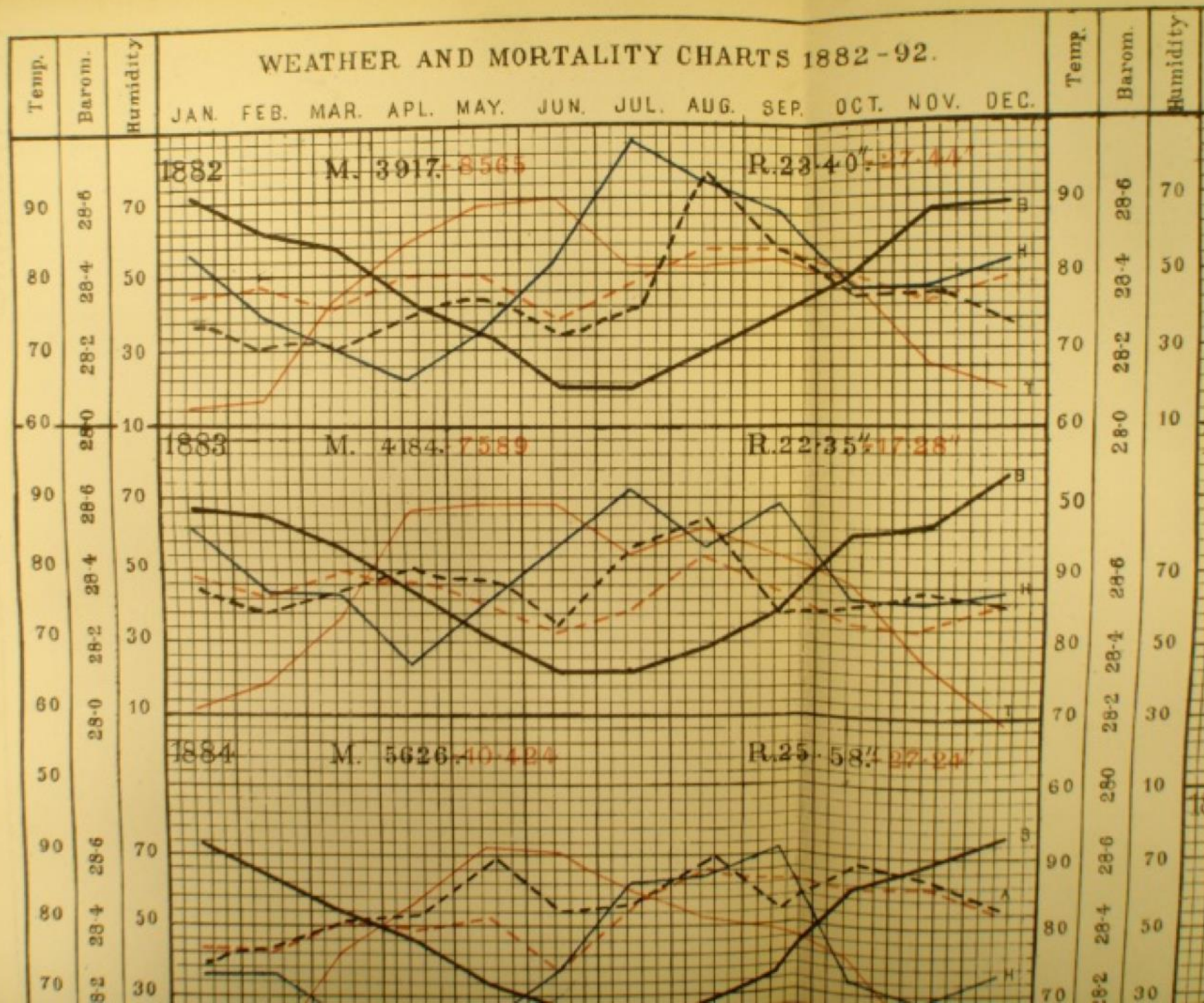
1876-1878 ENSO Droughts and Famines



* Based on Singh et al. (2018)

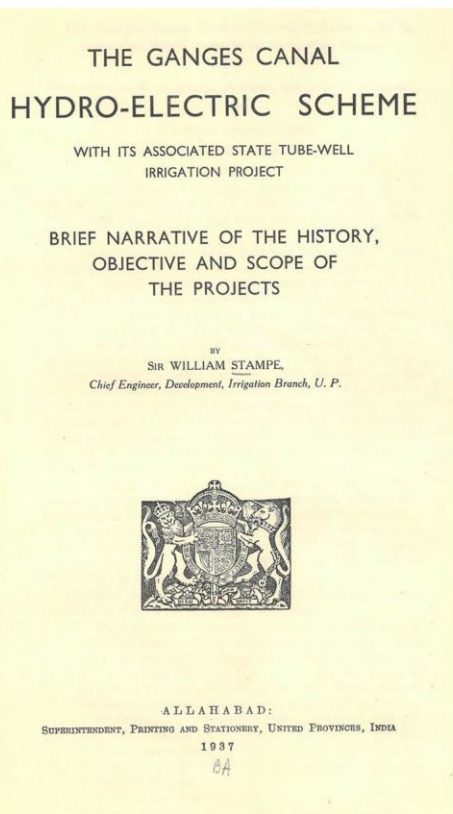
Source: Fonseca Hoeltgebaum (2023)

LongRunHealthMatters.com



1937 Indo-Gangetic Plains

Throughout the 1930s, British engineer William Leonard Stampe oversaw the Ganges Hydro-Electric Scheme. By 1937, ten of the thirteen engineered falls along the Upper Ganges Canal were outfitted with turbines, electrifying 88 villages and powering a network of some 1,500 tubewells capable of irrigating 1,000,000 acres (242,811 hectares). He established a new circuit between river diversion, canal, hydropower, and tubewell irrigation. The project became a model for other hydro-electric uses of state-owned tubewells around the world.



(20)

APPENDIX F
IRRIGATION DEVELOPMENT DIVISION EAST, MORADABAD
Progress of development of tube-wells in Bijoor and Moradabad Districts

Year	Number of tube-wells in operation		Total actual area irrigated by tube-wells		Average area per well		Actual cost per acre		Rainfall	
	Kharif	Rabi	Kharif	Rabi*	Kharif	Rabi*	Kharif	Rabi*	Kharif	Rabi
1	2 (a)	2 (b)	2 (a)	2 (b)	4 (a)	4 (b)	2 (a)	2 (b)	6 (a)	6 (b)
1933-34	12	27	1,068	589	89	27	6 5	2 5	37-24	8-39
1934-35	31	87	8,637	8,735	111	100	4 5	3 0	27	2-4
1935-36	178	389	16,068	28,082	90	88	8 0	3 3	29-4	2-0
1936-37	493	565	24,712	26,044	79	22	6 8	2 4	30-6	0-3
1937	570	..	36,290	..	88	..	6 12	..	29-0	..

*Includes sugarcane irrigated during rabi.

MADAN GOPAL SARDANA,
Superintending Engineer,
Development Circle (East).

APPENDIX G
Progress of development of tube-wells in Budaun and Bareilly Districts

Year	Number of tube-wells in operation		Total area irrigated by tube-wells		Average area per well		Actual cost per acre		Rainfall	
	Kharif	Rabi	Kharif	Rabi*	Kharif	Rabi*	Kharif	Rabi*	Kharif	Rabi
1	2 (a)	2 (b)	2 (a)	2 (b)	4 (a)	4 (b)	2 (a)	2 (b)	6 (a)	6 (b)
1933-34	..	..	30	..	1,523	..	125	..	3 4	..
1934-35	120	1100	765	18,700	38	120	7 8	2 0	109-29	2-01
1935-36	1300	..	15,458	..	21	..	6 0	..	10-0	..

*Includes sugarcane irrigated during rabi.

150 wells worked throughout Kharif 1935, and 20 more from May 15, 1936. Average number taken as 20.

1248 wells were running at the end of rabi season and only 100 in the beginning. 110 is the average number.

1200 wells were running at the beginning of Kharif season and 367 at the end. Average number taken as 300.

MADAN GOPAL SARDANA,
Superintending Engineer,
Development Circle (East).



William Leonard Stampe, *The Ganges Canal Hydro-Electric Scheme with its Associated State Tubewell Irrigation Project* (Allahabad: Superintendent, Printing and Stationery, United Provinces, 1937).





The Punjab National Bank Farm Financing Scheme offers direct financial assistance to farmers for a wide range of farming activities.

Short term loans repayable at the end of the harvest are made for the purchase of superior quality seeds, fertilisers, pesticides and insecticides.

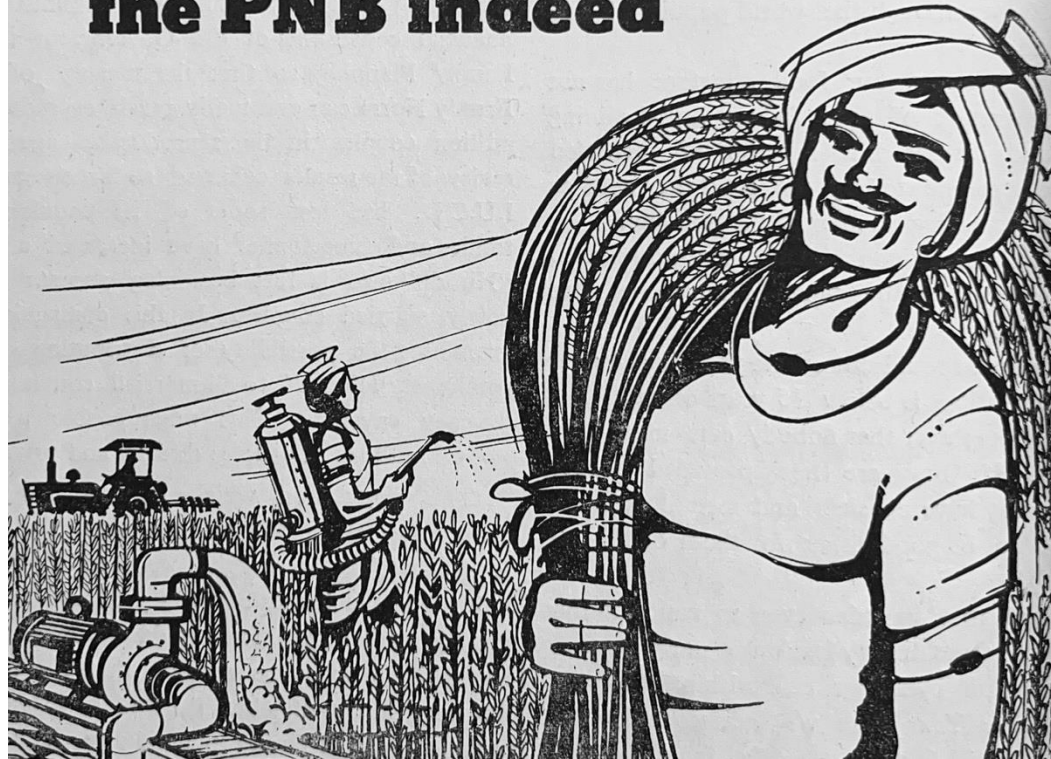
Medium term loans can be obtained for the development of land, irrigation facilities including electrification of wells and purchase of pumping sets, tractors and other agricultural implements. These loans are repayable in instalments within five years.

The scheme includes FREE TECHNICAL ADVICE on all farming problems.

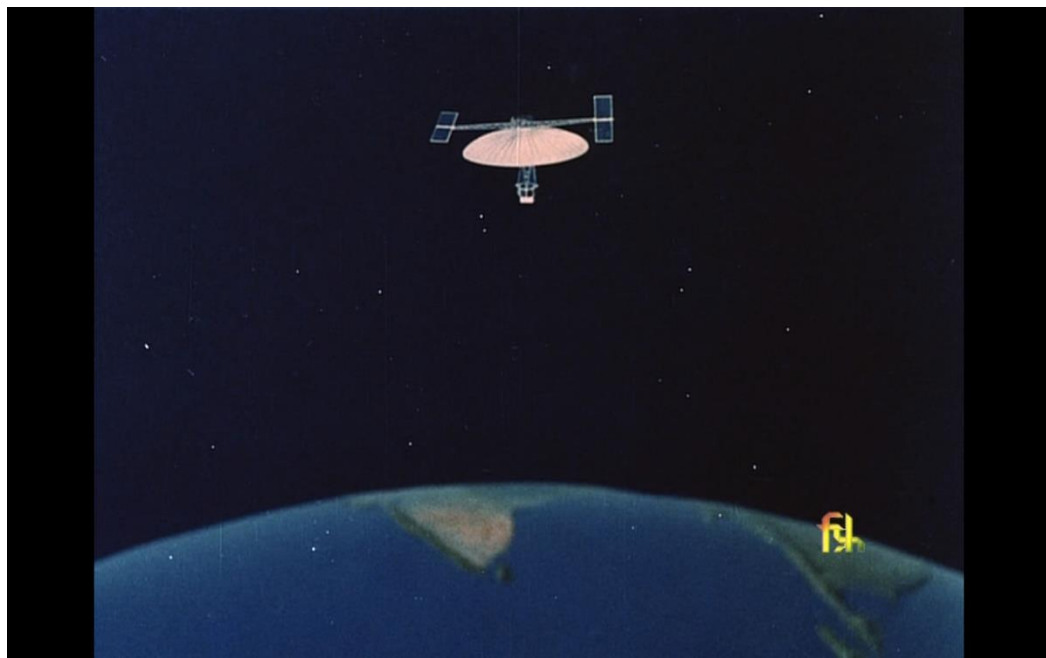
PUNJAB NATIONAL BANK

In the service of the
nation since 1895

**The farmer's friend
in need is
the PNB indeed**



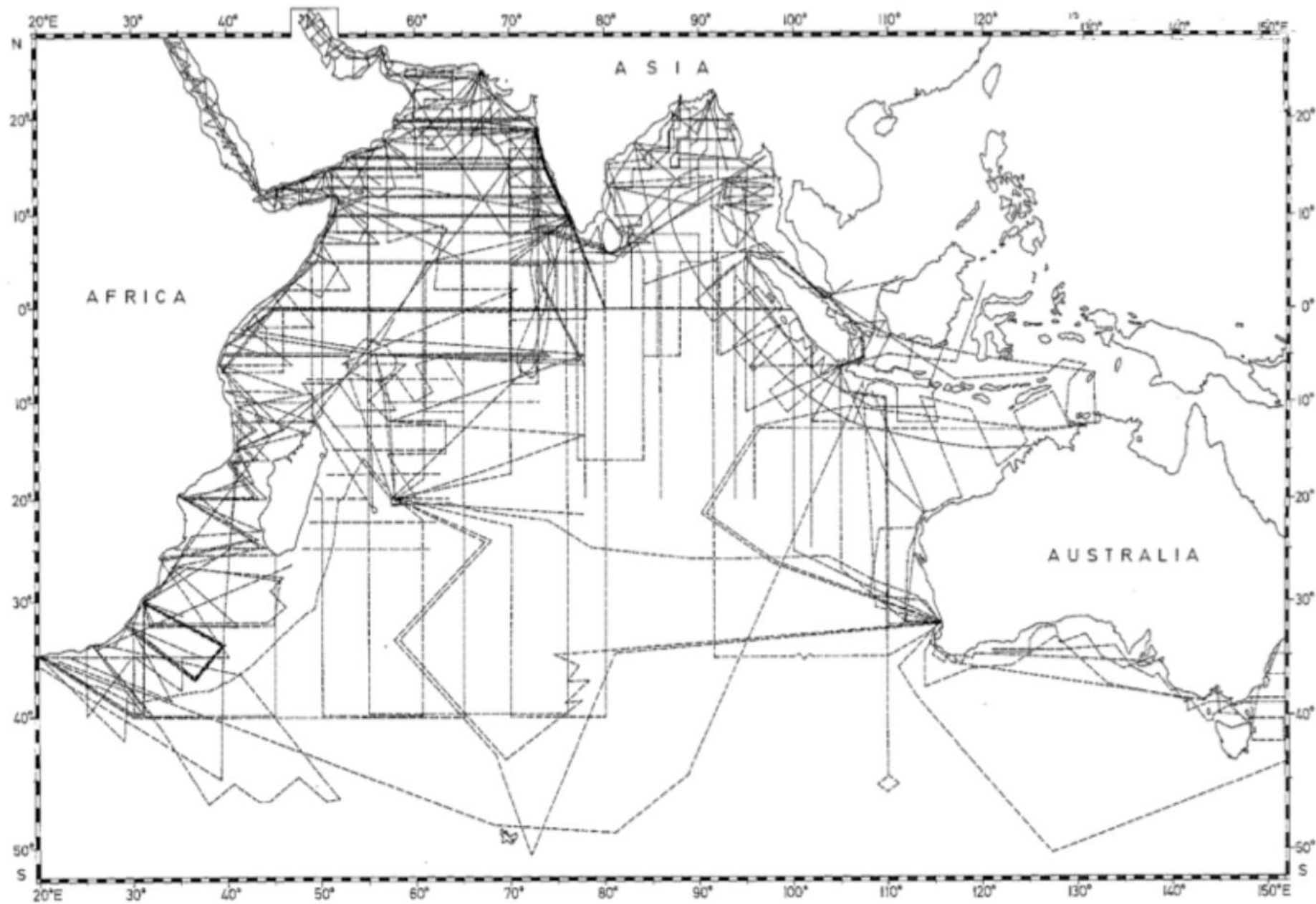








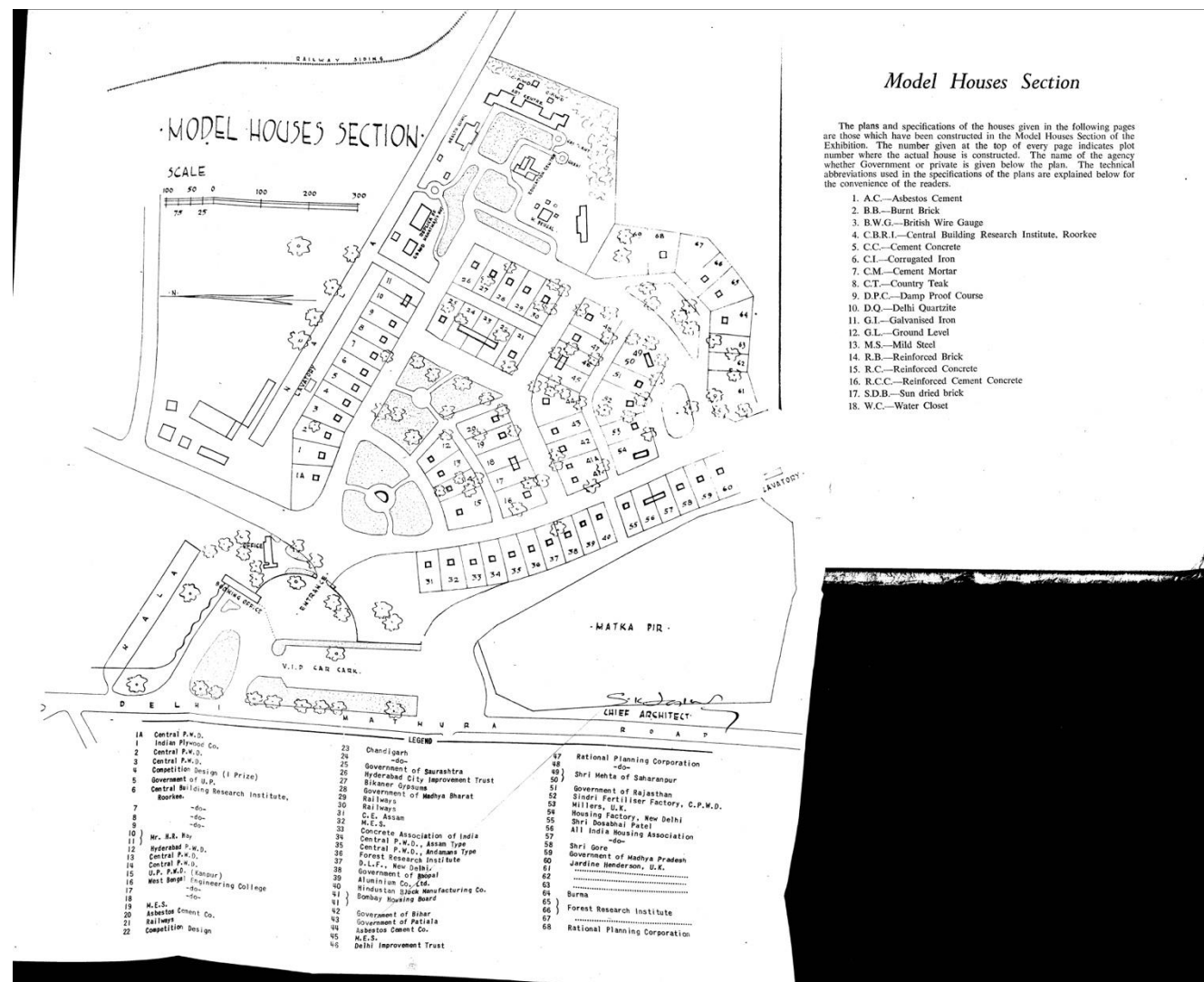




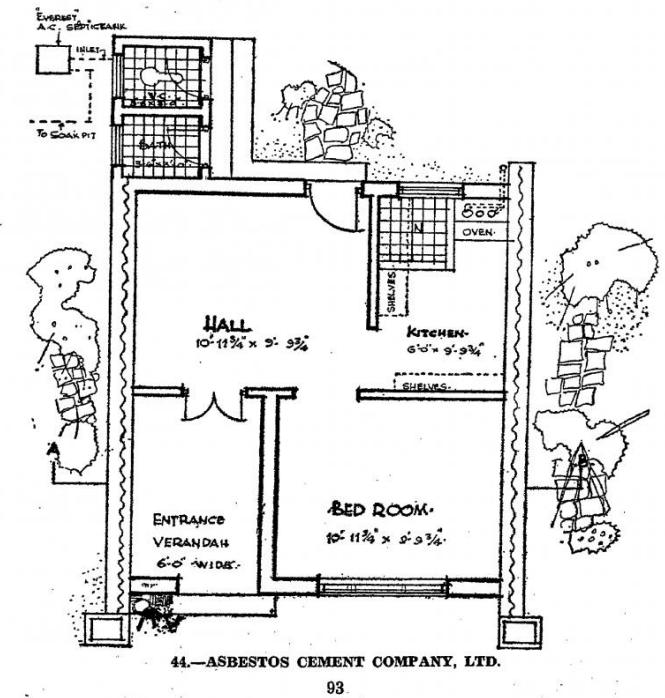
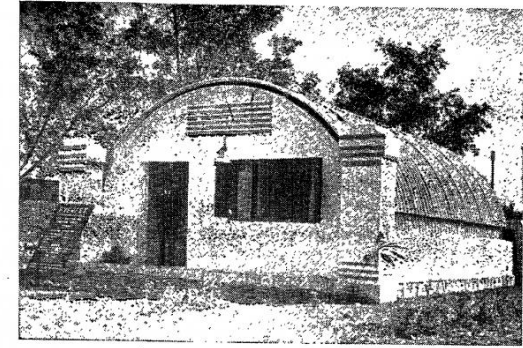
Cruise tracks of research vessels during the International Indian Ocean Expedition. Based on information from the Office of Oceanography, UNESCO Paris



Left: Jaqueline Tyrwhitt touring Prime Minister Nehru through the Model Village" New Delhi, 1954.

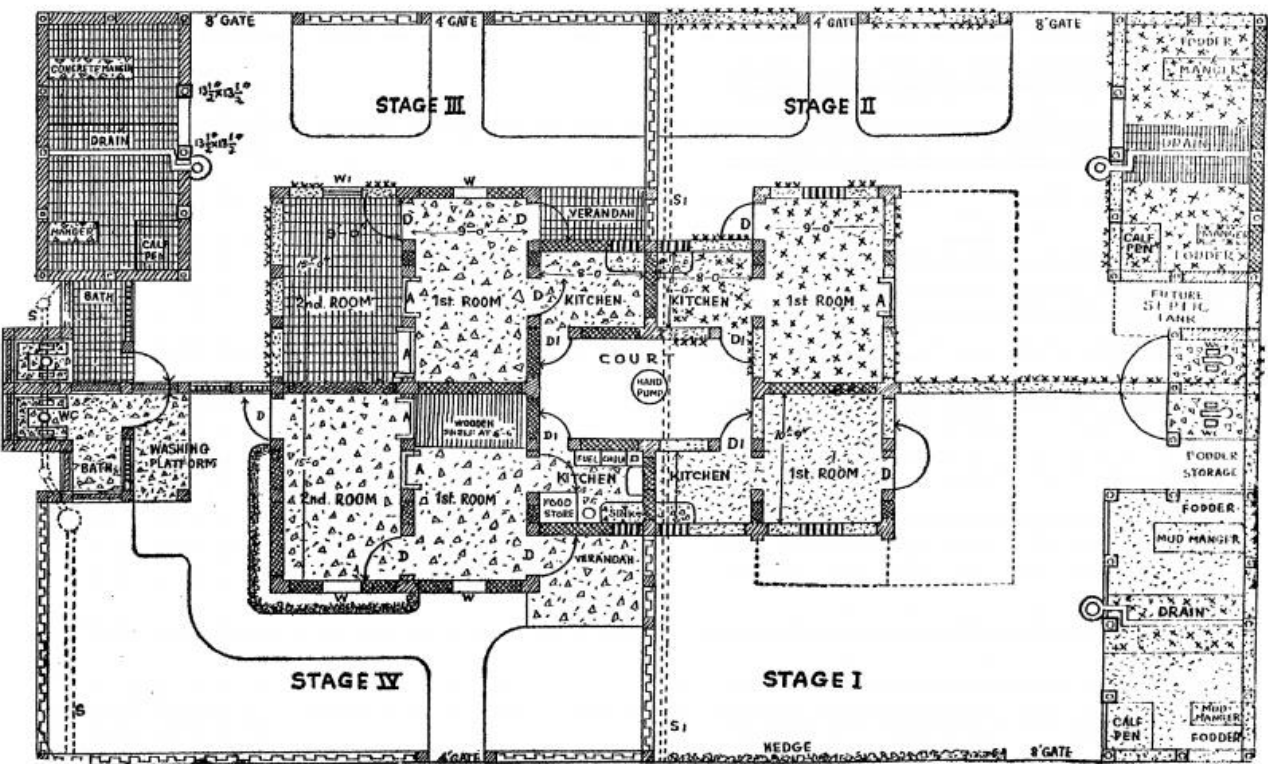


Right: Jaqueline Tyrwhitt, Model Houses Section Plan, New Delhi, 1954.



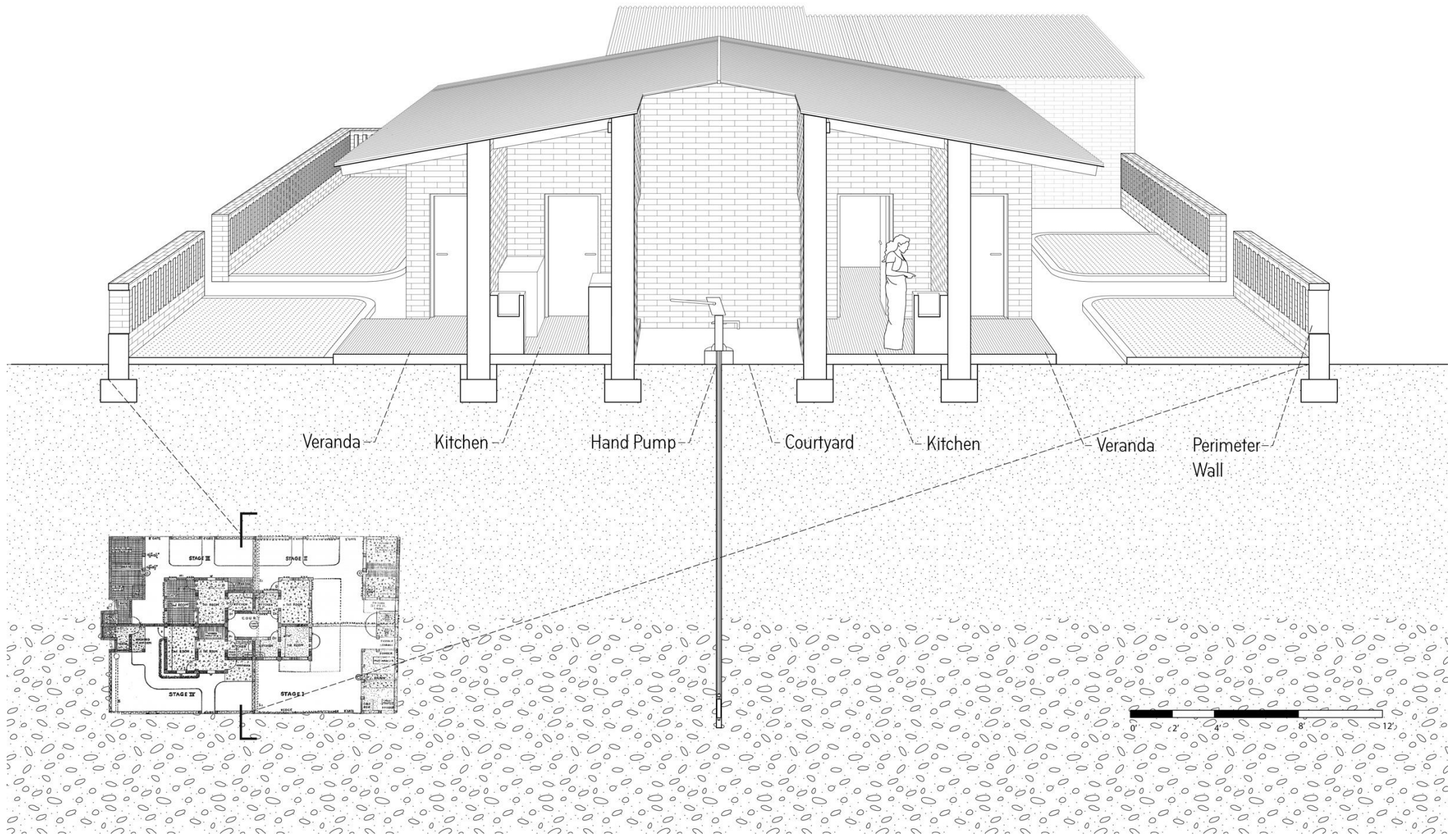
Left: M.P.s leaving Central Building Research Institute House, New Delhi, 1954.

Right: Photo and plan of Asbestos Cement Company House, New Delhi, 1954.

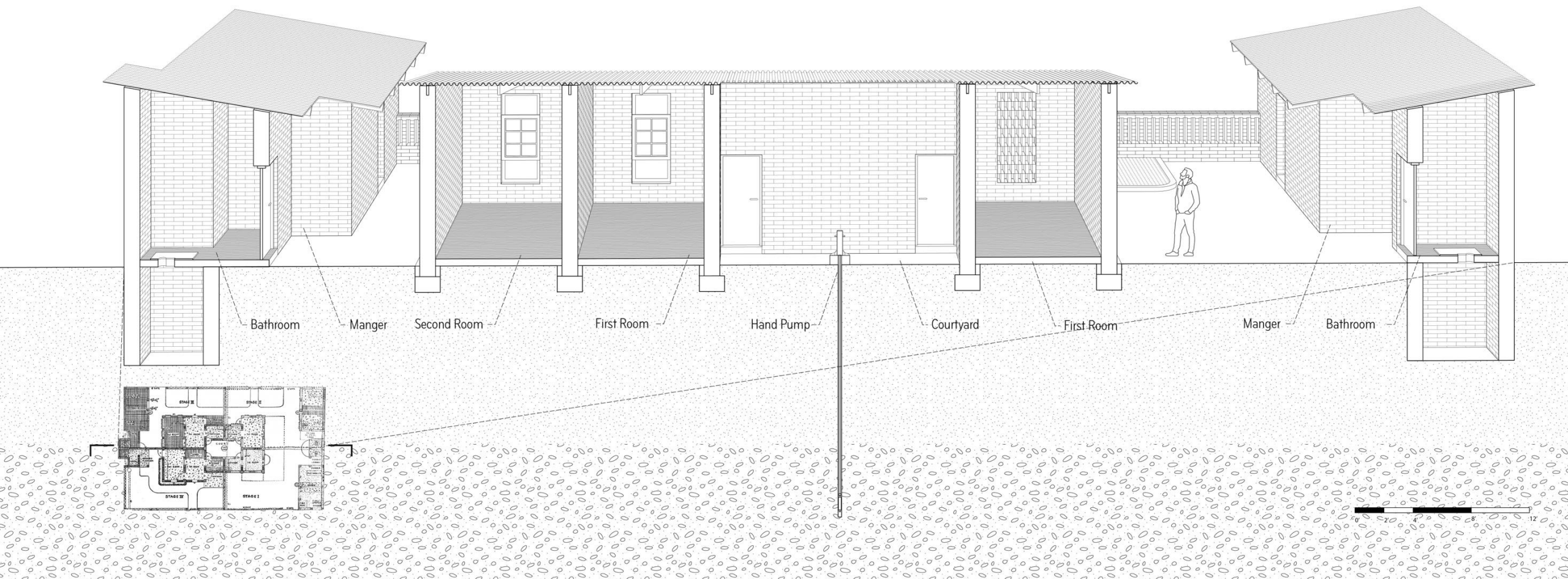


Left: Harold R. Hay, "Growing House Plan," New Delhi, 1954.

Right: Indira Gandhi and Prime Minister Nehru leaving "Growing House, New Delhi, 1954 (Harold R. Hay Papers).

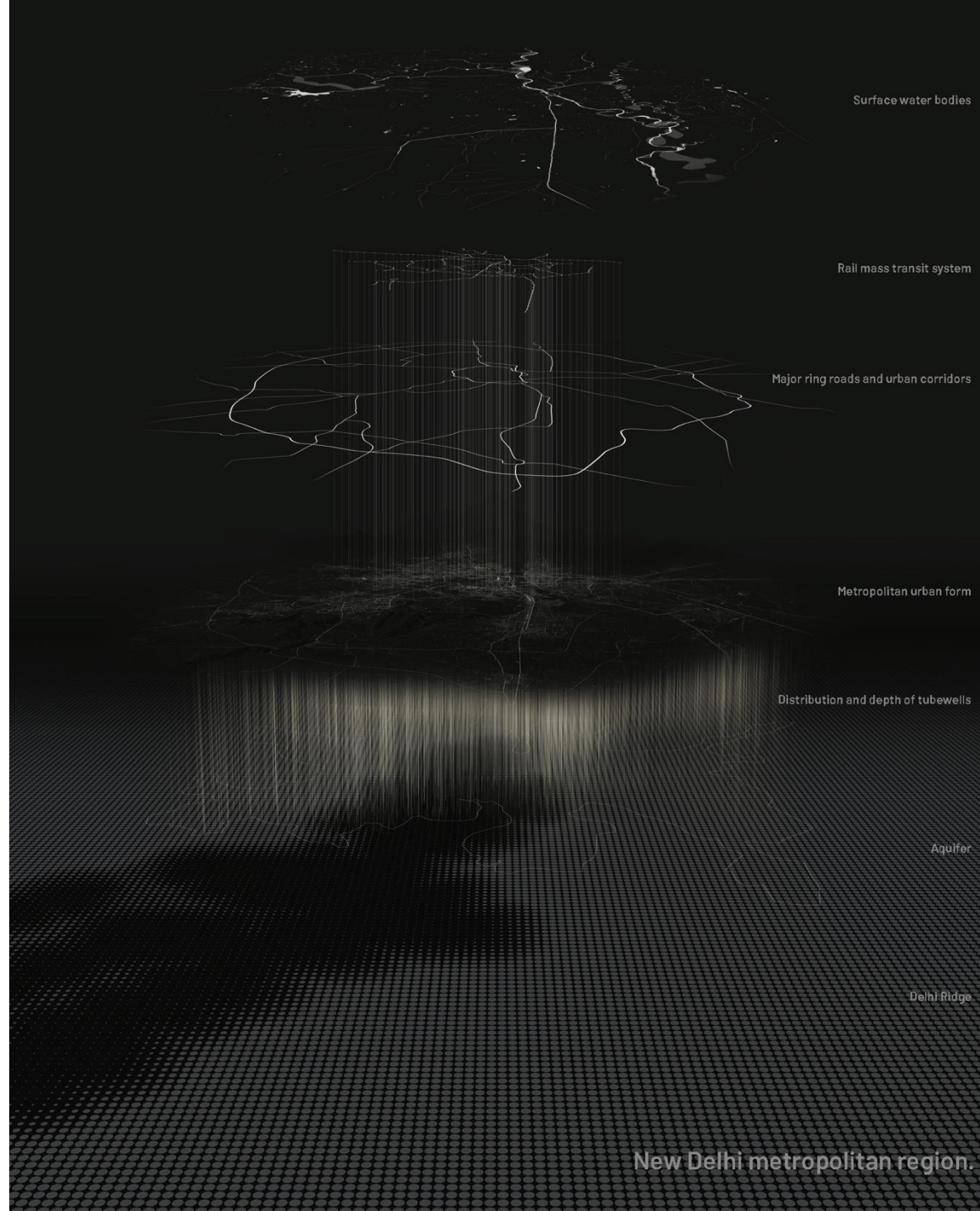


Transverse Section Perspective through "Growing House."

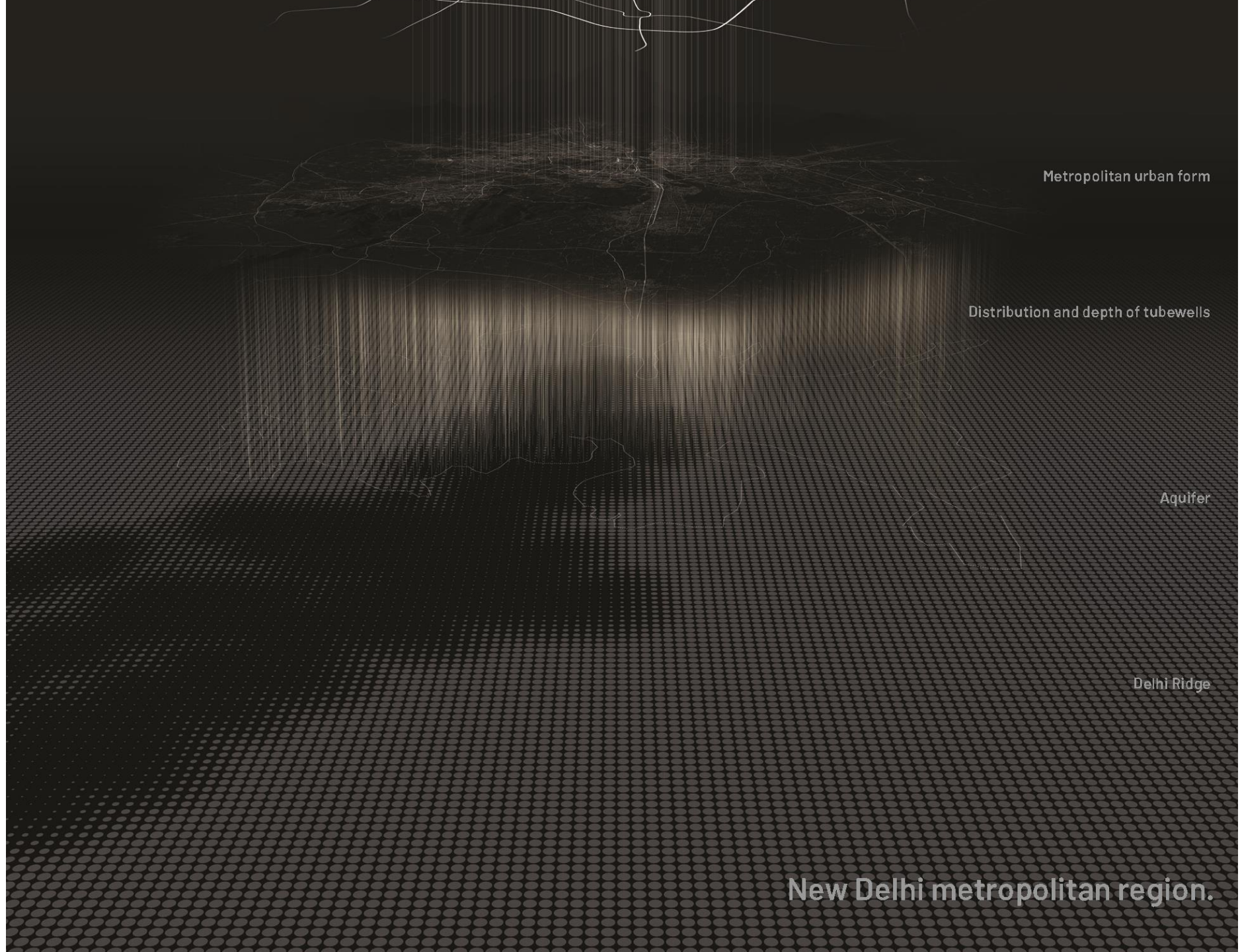


Longitudinal Section Perspective through "Growing House."





New Delhi metropolitan region.



Metropolitan urban form

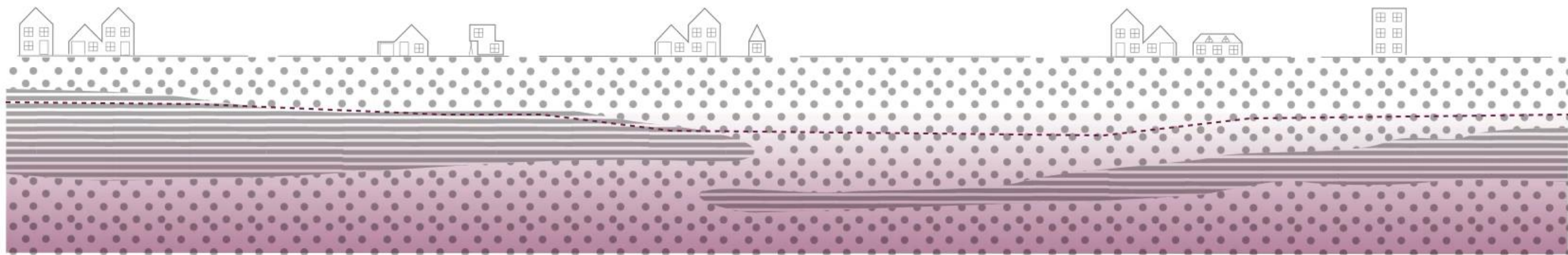
Distribution and depth of tubewells

Aquifer

Delhi Ridge

New Delhi metropolitan region.







1993 Indo-Gangetic Plains

In 1993, arsenic was first identified in tubewell water in Bangladesh. This article from 2002 details the long term effects and challenges of monitoring and managing groundwater extraction with naturally high levels levels of arsenic.

Arsenic in the water | *Slow death in Bangladesh*

‘The largest mass poisoning’ of a people in history

By Barry Bearak
The New York Times

CHOTOBINAR CHAP, Bangladesh
The arsenic, a slow, sadistic killer, has just about finished its work on Fazila Khatun. She toeters now. The fatigue is constant. Pain pulses through her limbs. Warts and sores cover the palms of her hands and the soles of her feet, telltale of the long years of creeping poison.

Khatun is hardly alone in this suffering. Bangladesh is in the midst of what the World Health Organization calls the “largest mass poisoning of a population in history.” Tens of thousands of Bangladeshis show the outward signs of the same decline. About 35 million are drinking arsenic-contaminated water, the poison accumulating within them day by day, sip by sip.

For two decades, the government, with United Nations aid, has been desperately worked to wean the nation from pond water, often an incubator for lethal disease. People were urged to install tube wells, tapping into the plentiful supply of underground aquifers. But no one had tested these subterranean sources for arsenic.

By the mid-1990s, Bangladeshi officials — once reluctant to provoke alarm — finally admitted that yet another tragedy was unfolding in their impoverished, disaster-plagued nation. In 1998, the World Bank spent the normal paperwork and lent the government \$32.4 million to act on the emergency. Every tube well was to be tested. Safe sources of water were to be provided.

But the “arsenic mitigation project” has been hobbled by the unforeseen problems of so unprecedented a crisis. It is yet another example of how the world’s poor continue to die from unsafe water, a threat long ago surmounted by the wealthy.

Suspicious of each other, the World Bank and the government became stubbornly bound up in their mutual bureaucracies, many critics say. Most of the country’s estimated 11 million wells have yet to be tested. Most stricken villages are without electricity. Most people — the trusting converts to the “safety” of tube wells — are baffled when now told that within the water lie the malign beginnings of arsenic-induced cancer.

“It seems like nonsense to people, telling them the water is killing them when it looks so clean and nice,” said Allan Smith, an epidemiologist at the University of California at Berkeley and an expert on arsenic.

Smith has called this “the highest environmental cancer risk ever found,” worse than Bhopal or Chernobyl.

“People need to stop drinking the contaminated water,” he said. “But they don’t seem to pay attention unless there are people around them showing

signs of the disease, which is of course what we’re trying to prevent.”

Here in the village of Chotobinar Chap, with the cancer pulling her under, Khatun seems to have surrendered. She has no strength for work. She has no appetite for meals. She lies in a spare room beneath a thatched roof.

“I feel myself fading away, and sometimes I ask God to take me,” she muttered. “My husband has abandoned me. He doesn’t even look at me anymore.”

For nearly two decades, Khatun, 39, pumped the iron handle of a tube well sunk in her front yard beside a palm tree. Her father-in-law, Abdul Hakim, his six sons and all their families used the same convenient apparatus.

Two years ago, the water was tested. The arsenic concentration measured 760 milligrams per liter, 15 times the amount considered safe by Bangladeshi standards and 75 times the limit set by the World Health Organization.

Arsenic, a speedy killer in high doses, is a sluggish and fickle assailant in low ones. The poison requires two to 10 years or more to work its damage and it affects different people in different ways — and some, seemingly, not at all.

While Khatun is the most woe-fallen stricken in her family, others have the same nodules on their palms and heels and dark spots on much of their skin. Still others, their thirst slaked from the same well, show no signs at all.

Informed of the danger, the family beseeched, “Where can we get safe water?” Here again the arsenic displayed its erratic hand, for some of the wells here are terribly tainted and others, just yards away, are harmless.

The nearest safe water for the family was beside a neighbor’s home a quarter mile away.

“It was hard to fetch water from so far away,” said Hakim, a weaver. Dark spots pocked his bare chest. “One of my daughters-in-law would go and carry back a full pitcher for drinking. But sometimes the path was too muddy. It was knee-deep. She couldn’t wade through it and she stopped going.”

It is difficult to predict how many Bangladeshis will eventually die from causes related to the arsenic. Richard Wilson, a Harvard physicist who is an expert in risk analysis, puts the number at 1 million. Dr. Shabbir Ahmad, a government public health specialist, predicts a total of 3 million to 5 million.

Any such arithmetic is highly speculative. The morbid work of the arsenic is a persistent nagging threat. Cancers of the liver, lung, bladder or kidney — can be halted in most cases by simply switching to safe water, doctors say.

So the question is: How many Bangladeshis will be persuaded to switch? And, if persuaded, how many

can find water both safe and accessible?

Alternatives do exist. There are even ways to filter arsenic from water. But each solution requires effort, to educate villagers and to pay for the required equipment.

With 140 million people, Bangladesh is the world’s eighth most populous nation, its citizens packed into a territory slightly smaller than Wisconsin. The average per capita income is \$370.

Arsenic has competition on the nation’s mortality tables. Each year, pneumonia kills 9,000 children under age 5. Diarrhea claims 6,000 more. Tobacco surely rivals arsenic as a progenitor of fatal cancer.

Mother Nature, prone to furious mood swings, is often a mass murderer. In the wet summers, melting snow from the Himalayas joins with monsoon rains to overwhelm the rivers, flooding as much as two-thirds of the landscape. In dry months, the fiercer sun can parch the soil enough to trigger a famine.

A few kilometers from here is Khandkar Kalagachia. As in most hamlets, there is water everywhere: wells, ponds, irrigated fields.

Though many of the villagers display signs of the poisoning, it is hard to know the extent of the contamination. Khandkar Kalagachia is among the 77 percent of the nation’s “hot spot” areas still untested.

Mohammed Ahsanullah, a rickshaw puller, endures an overwhelming itchiness, another of the symptoms. His hands are always in motion, scratching their way from his palms to his wrists to his biceps to his shoulders. In one dexterous maneuver, he crosses his arms to get at his sides, looking like a man confined to a strait-jacket.

“I should drink from another well,” Ahsanullah, 45, said.

His fingers have lesions the size of chickpeas. His soles are similarly affected, a hazardous problem for a rickshaw puller who goes barefoot. Infected wounds often lead to gangrene.

From the start, the rescue effort was riddled with problems. The primary mission was the testing of every well. If the water was safe, the top of the well was to be painted green. If not, it would be colored red.

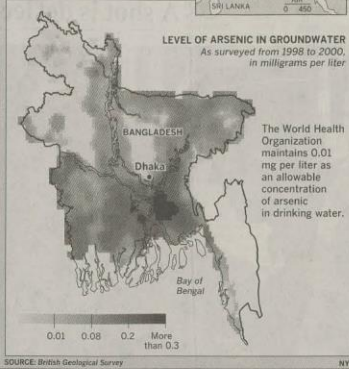
This task required test kits that could accurately measure minuscule levels of arsenic, but nothing that precise was immediately available. While it was presumed that every family had a right to know if their well was tainted, little had been decided about how to help the unlucky.

“We started taking the measurements, but as we tested, painting the wells red or green, there was a great hue and cry from people with contaminated water,” a government official said. “These people asked us, ‘What do you expect us to do now?’”

Poisoning of a Population

About 26 percent of Bangladeshis are drinking arsenic-contaminated water from tube wells.

For two decades, people were urged to install tube wells to get water from underground aquifers that were deemed safer than pond water. The aquifers, however, were not tested for naturally occurring arsenic.



“It took us a while to come up with new technologies, such as pond sand filters or rainwater harvesting or, in some areas, deeper tube wells,” the official said. “Different areas have different solutions. But once the best one is decided, to whom do you provide the money for installation? How do you prevent corruption?”

Programs were required, and each one seemed to call for round after round of design. The World Bank, after lending so much money, wanted the protection of exacting oversight. Some government officials, practiced in steering contracts to cronies, had supervisory interests of their own.

“It has been terrible frustration to watch,” said Han Heijnen, the environmental health adviser for the World Health Organization in Dhaka, the capital. “So much remains to be done. Even now, the lack of knowledge among villagers about arsenic is a shame.”

The arsenic itself may well have been in the area’s alluvial sediments

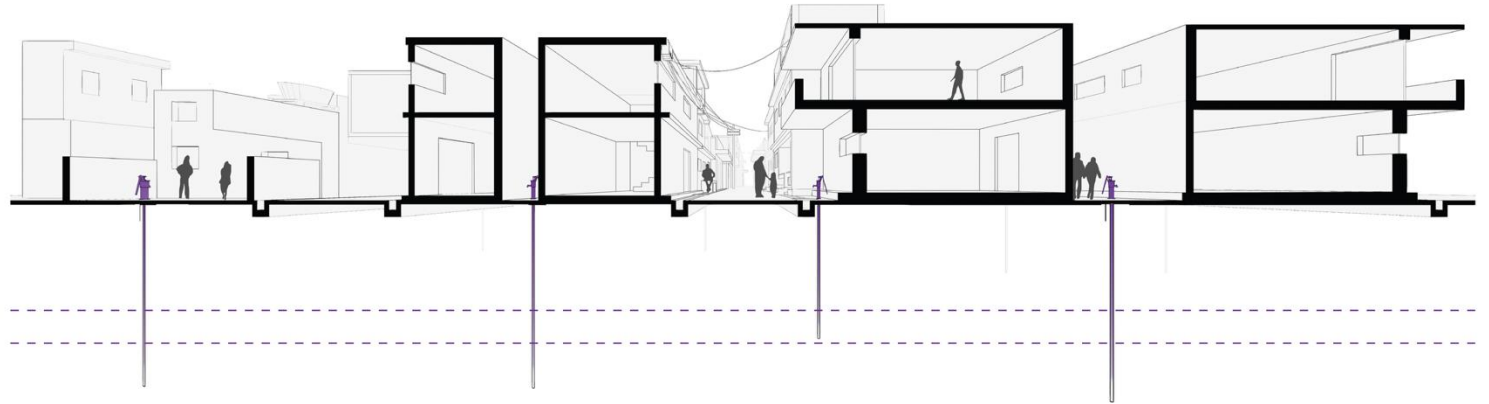
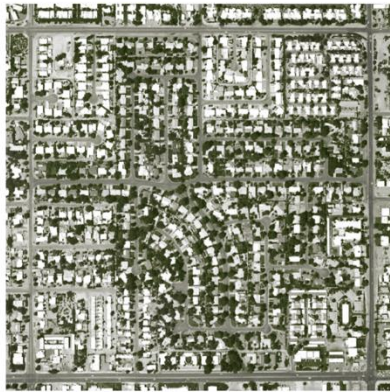
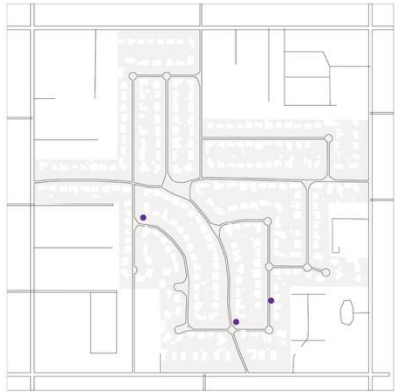
for 20,000 years or more. Exactly how it came to dissolve in the groundwater is a matter of debate, but the prevailing theory is that it was a natural process.

Whatever the cause, the arsenic’s belated discovery is at the root of the calamity. Water-quality experts are divided about how much, if any, negligence was involved. Some victims are suing the British Geological Survey, which did not include a test for arsenic when it surveyed the groundwater in 1992.

Ahsanullah, the rickshaw puller, incessantly scratching, had given thought to an alternate source of water. Recently, he began using a neighbor’s well.

“But now I am told that, too, is bad,” he said as he stood amid lush greenery and sprawling ponds. Within 6 meters (20 feet), villagers were sloshing through the shallows that nourished a rice paddy. Still, the confused man, displaying his fear, asked gravely, “Where can I find water?”

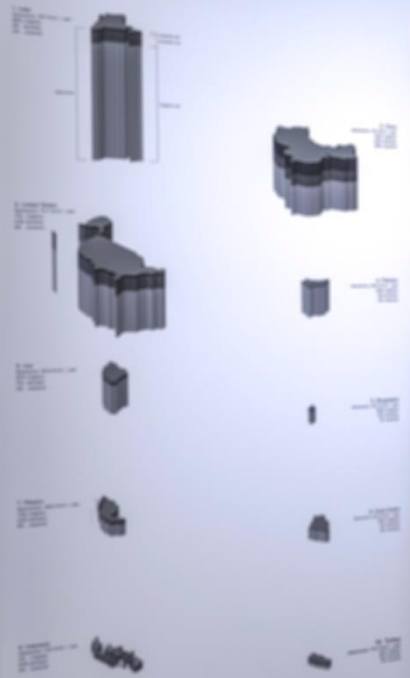




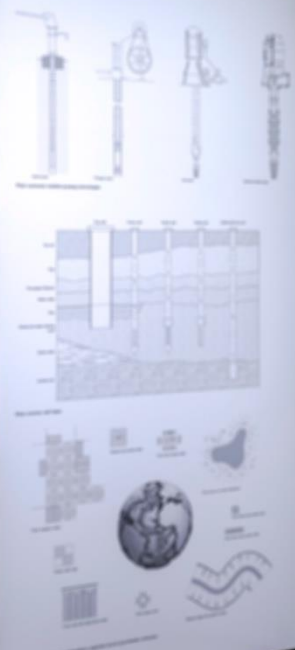
The three private tubewells provide low-cost water for landscaping and outdoor usage. Over time, the lushness of the ground is quite striking when compared with its immediate surroundings that rely on municipal water sources and regulations.

Section Perspective of Loni showing the ubiquity of private and public hand pumps, with groundwater levels dropping significantly due to overextraction and the multiplication of impermeable surfaces (roads and buildings).

Groundwater Earth



Pumps and Wells



Pumps / Tanks



New Delhi

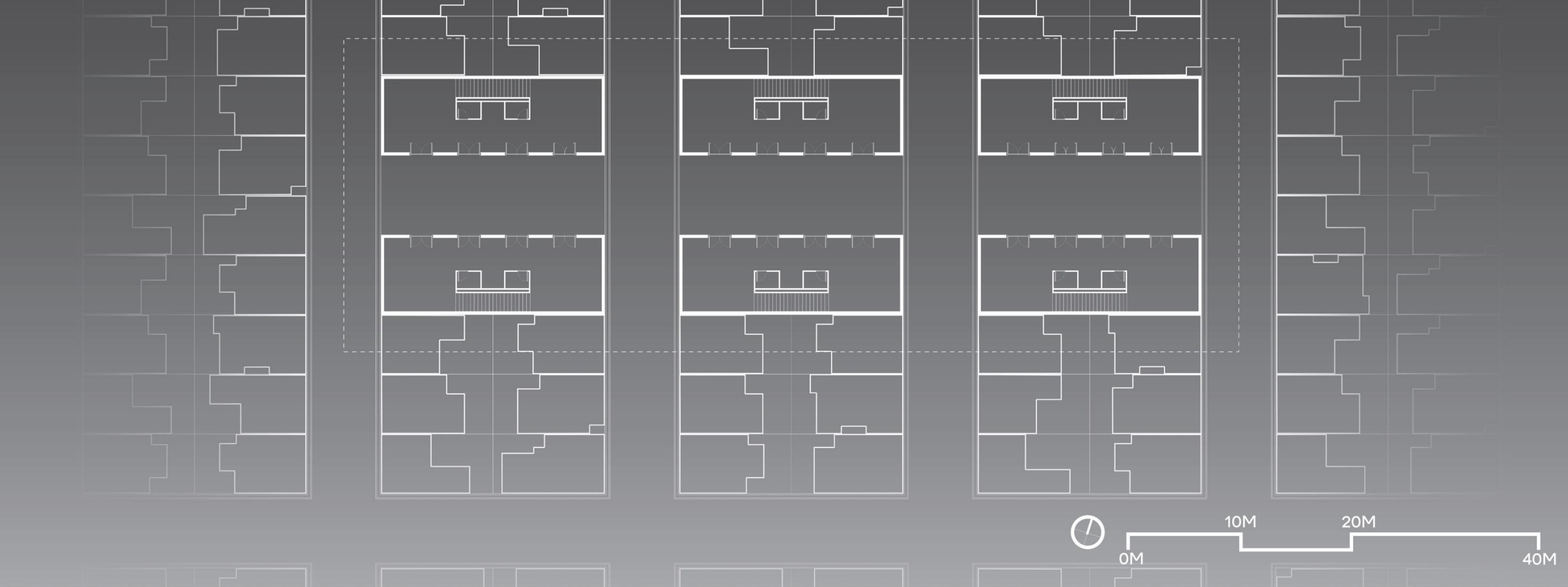
View of the New Delhi metropolitan region showing the extent of its urban form. The drawing highlights the drastic changes in depth of the water table in the area. This water more experienced subsidence along the western areas of the metropolitan region. In contrast, the eastern edge where the water table is much more stable, allows for access to the aquifer with less sophisticated pumping equipment.



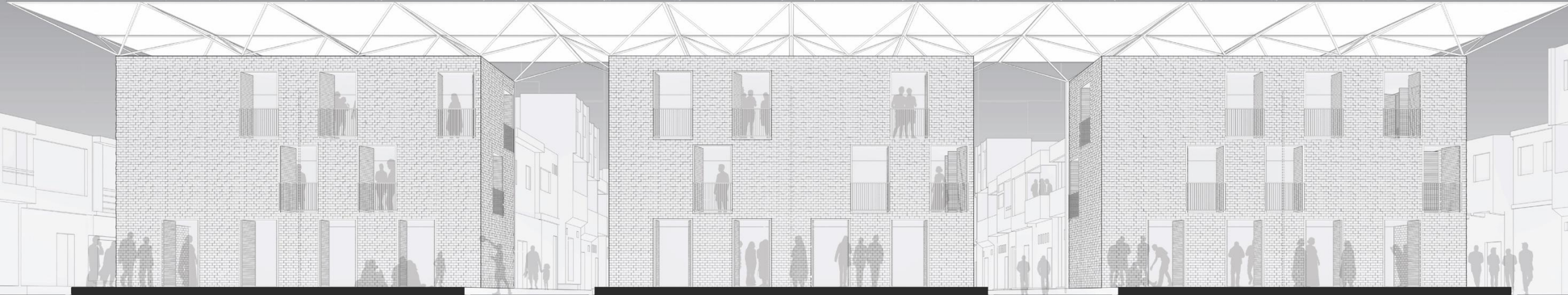


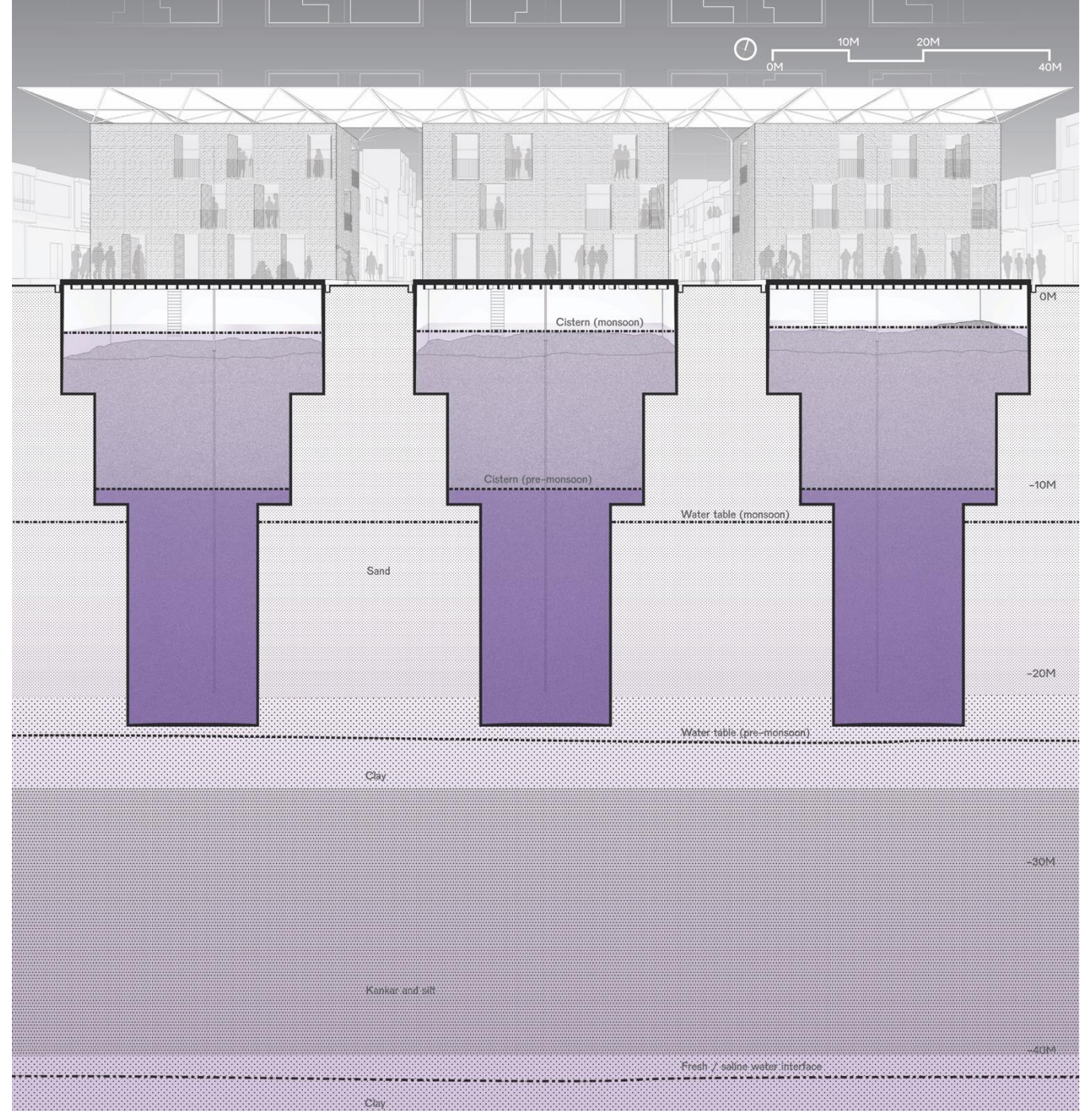




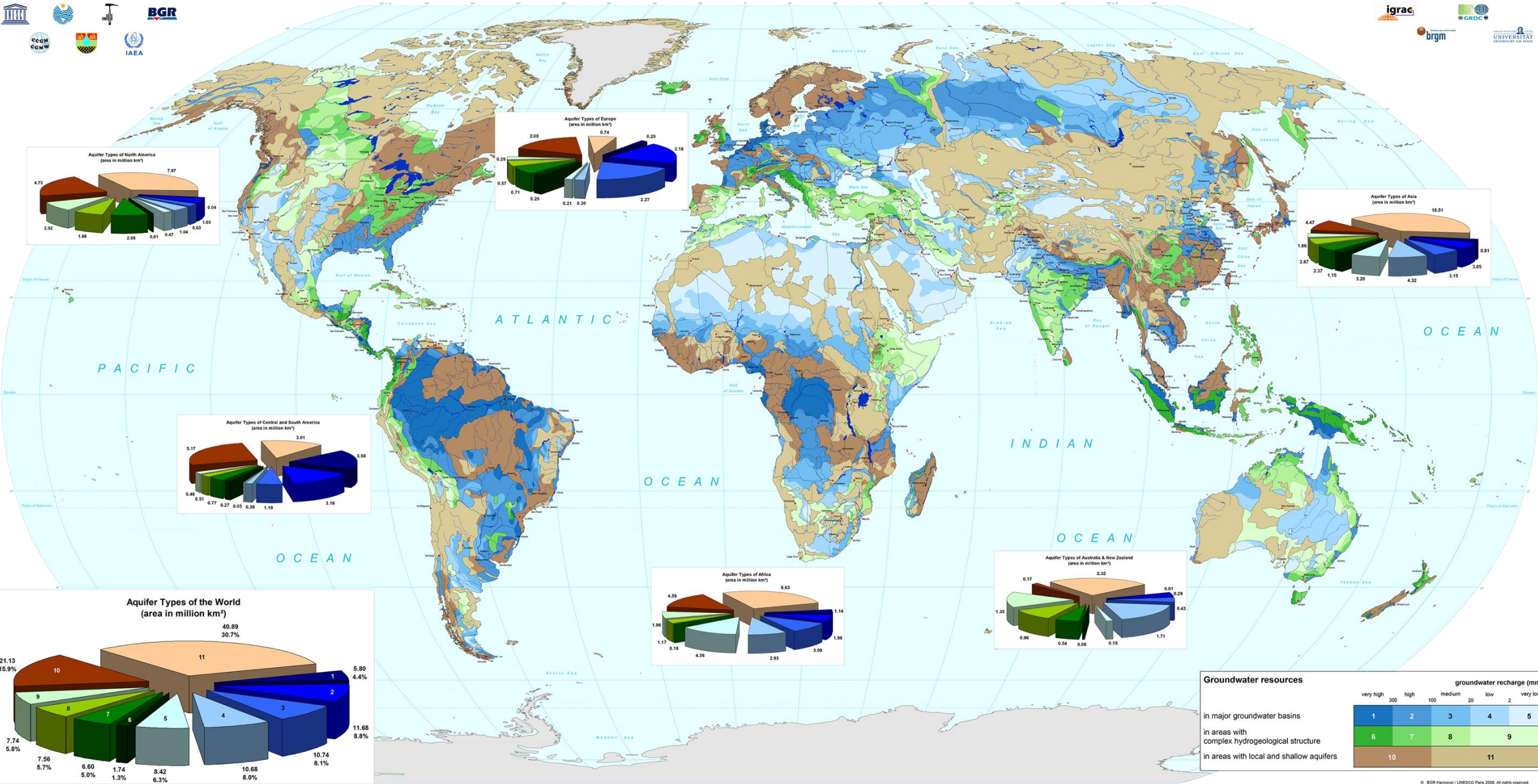


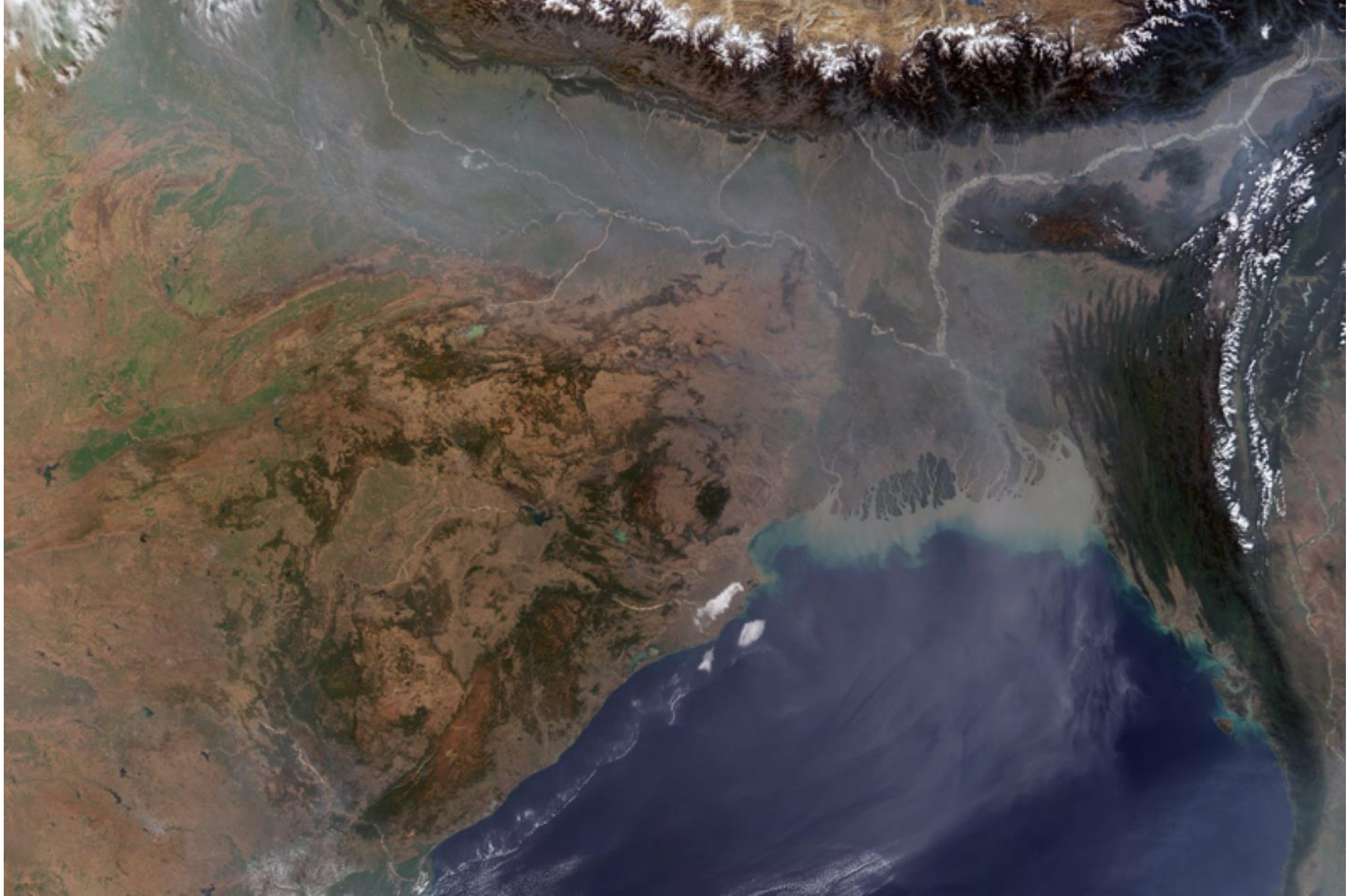
0M 10M 20M 40M





Groundwater Resources of the World

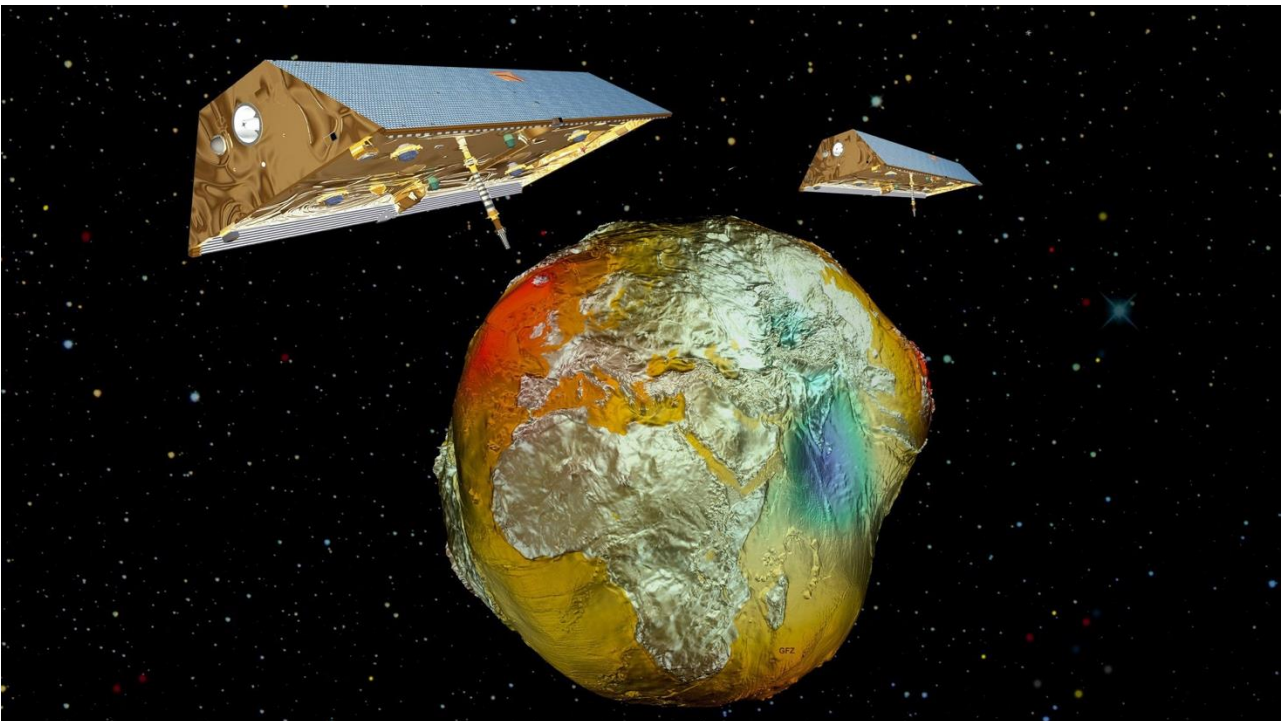




Major rivers fed by Himalayan glaciers

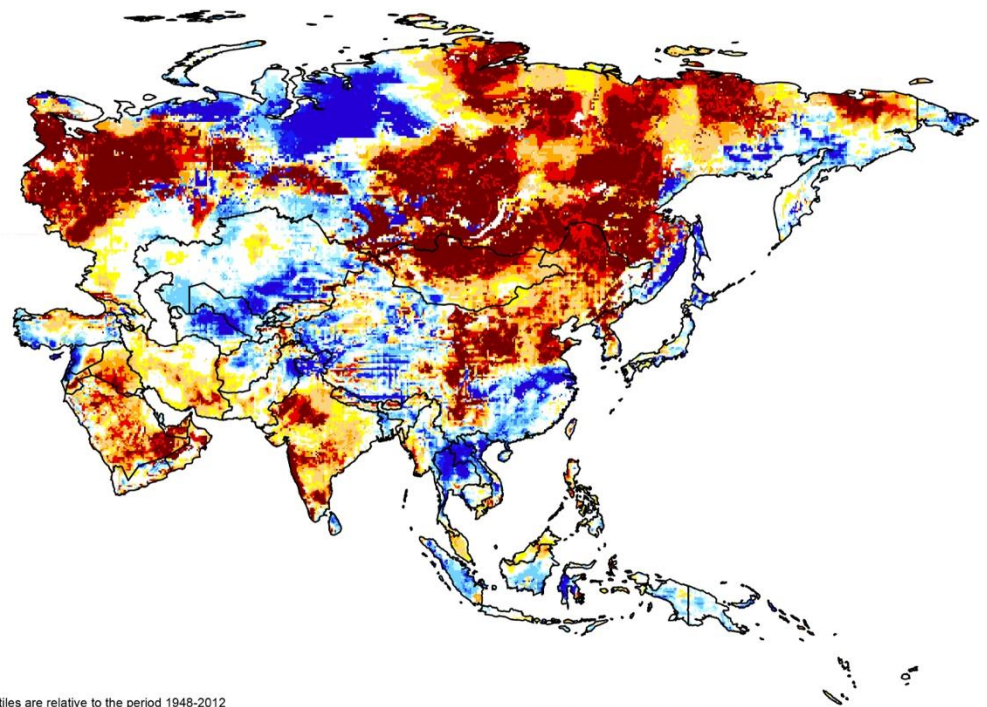
Seven of Asia's major river systems begin in the Himalayan glaciers. The environmental impact of shrinking glaciers on the 1.3 billion people in the region is just now being measured.



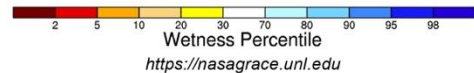


GRACE-Based Shallow Groundwater Drought Indicator

March 31, 2003



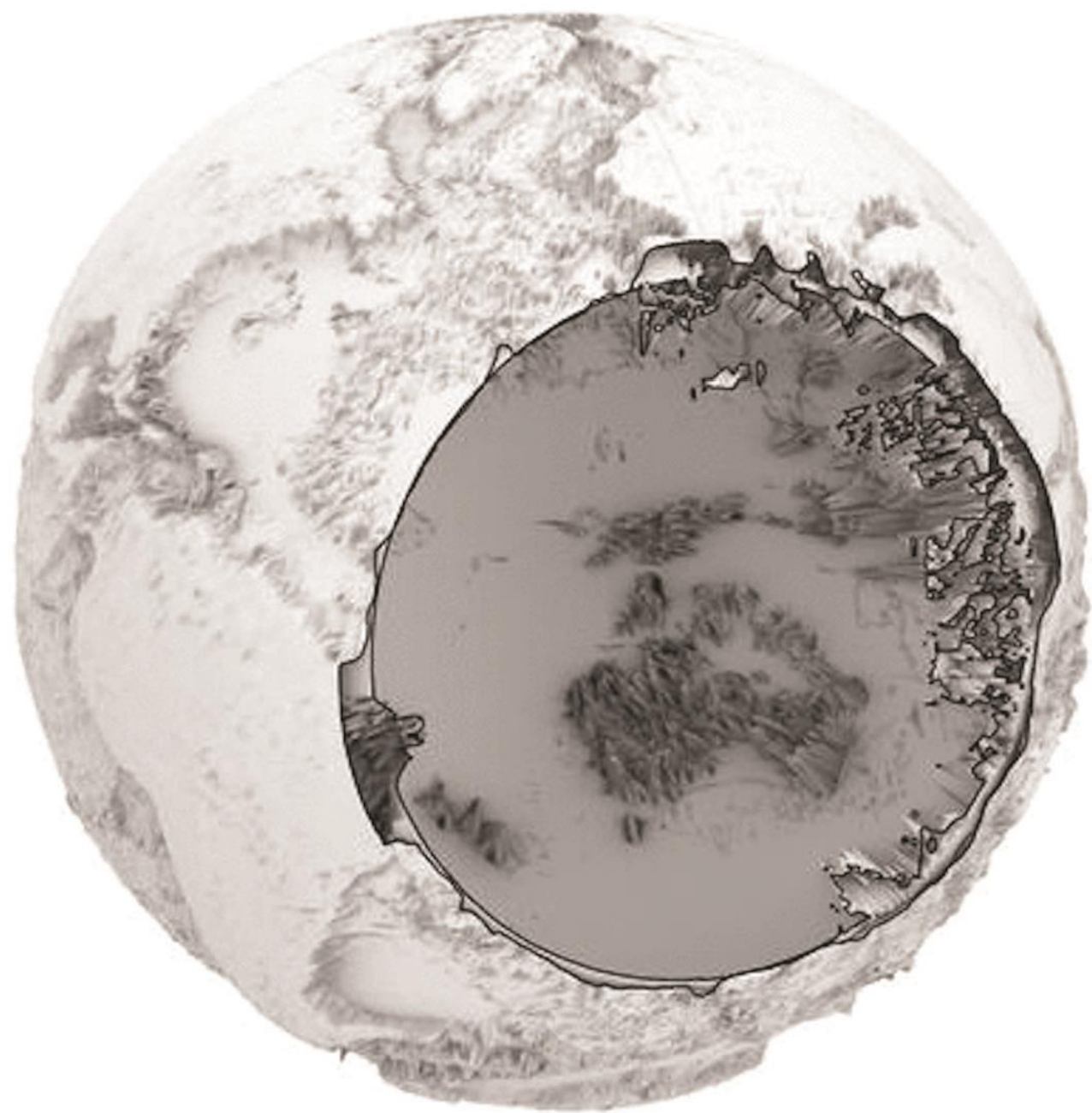
Wetness percentiles are relative to the period 1948-2012
The ground water depth
Cell Resolution 0.25 degrees
Projection of this document is Patterson (World)

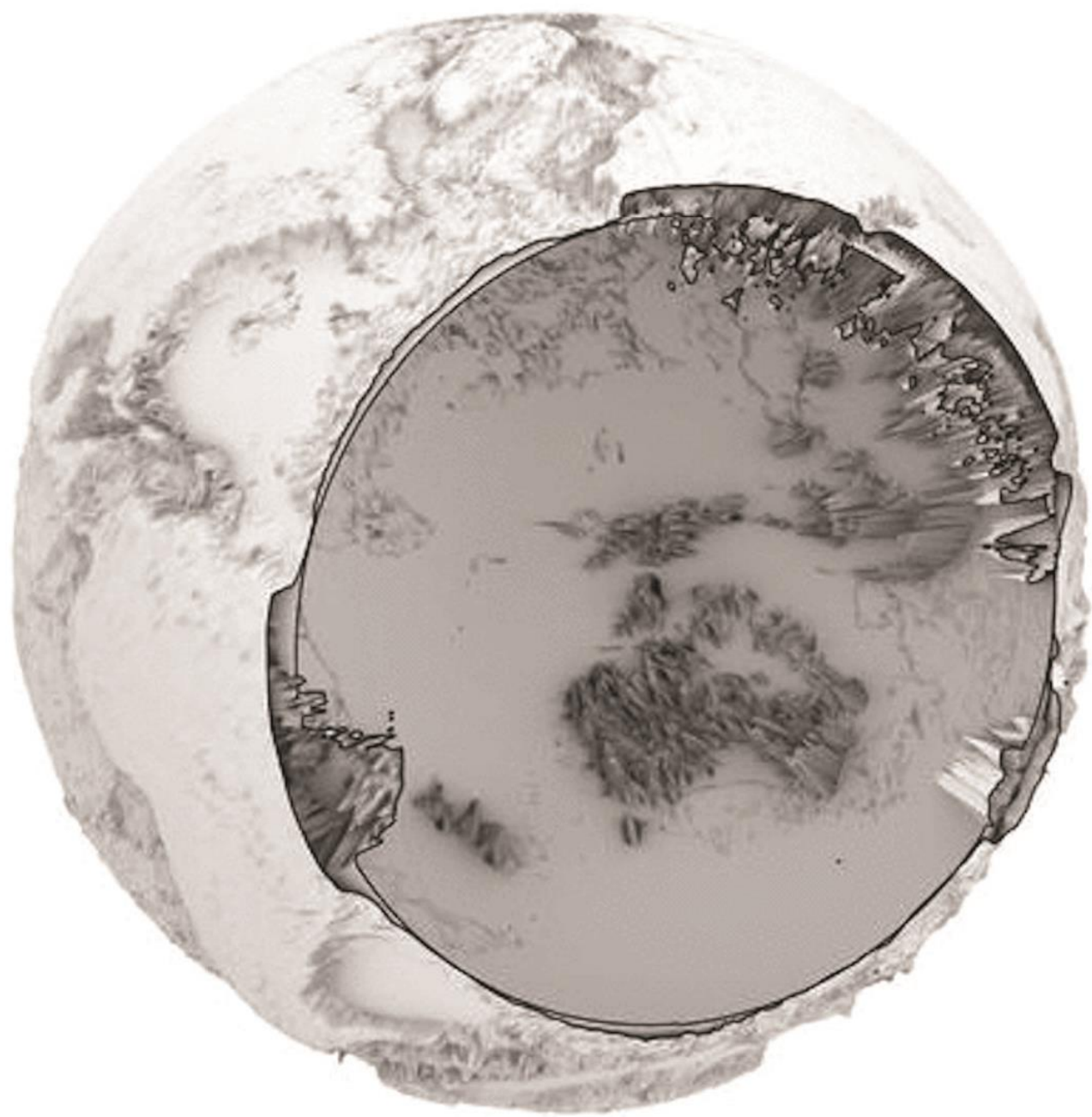


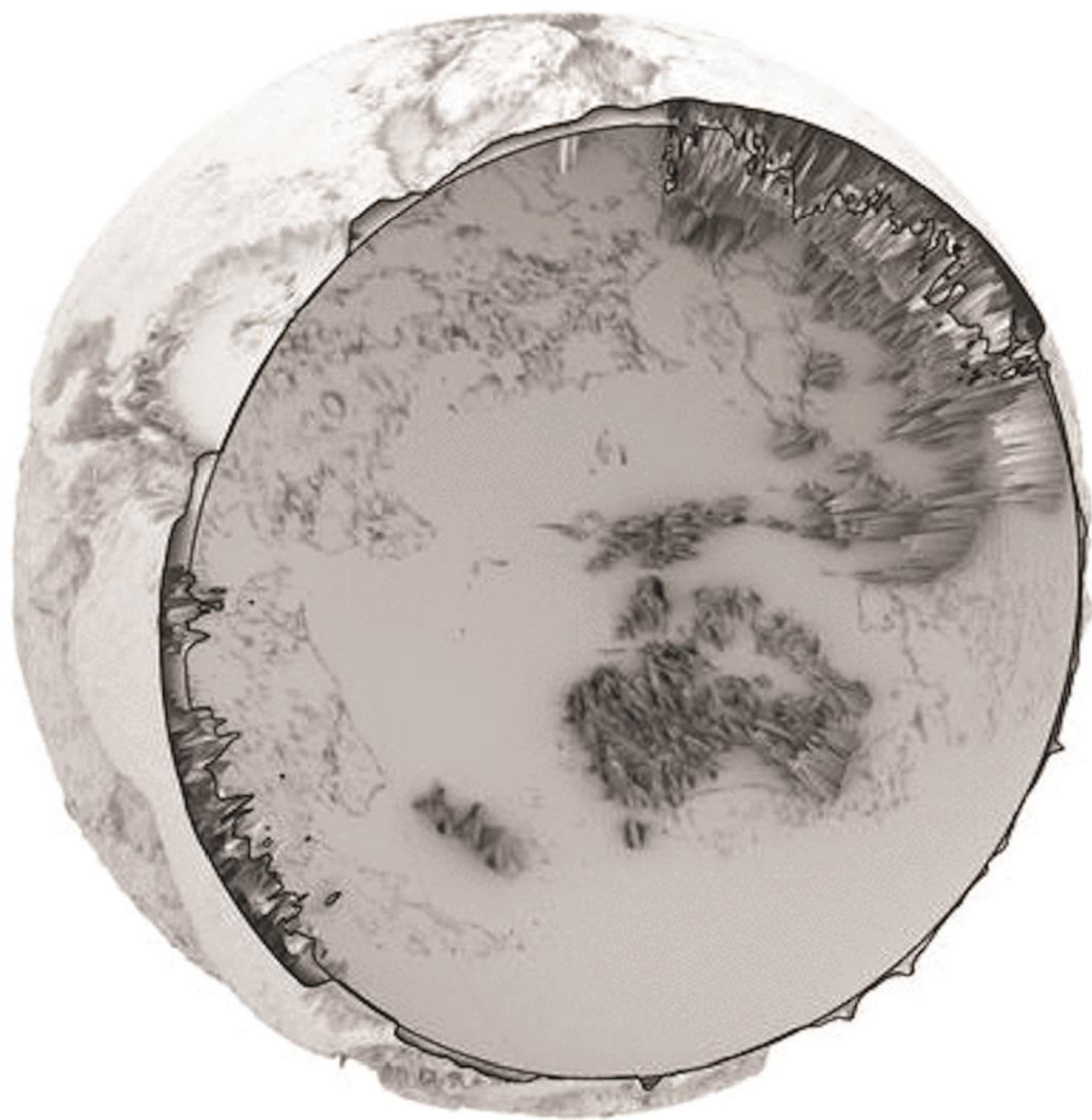


Den Aardkloot van water ontbloot, na twee zyden aante sien.

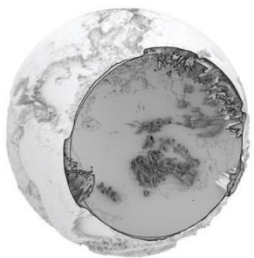








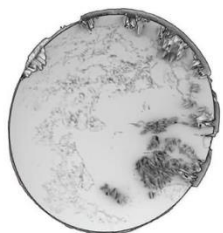




Section A



Section B



Section C

